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Recent Photographs Showing Progress on the Panama Canal

In our issue of Jan. 25 last was shown a diagram graphically illustrating how near completion was Culebra Cut on Jan. 1, 1912. Since then at least one-fifth of the remaining material has been excavated. The accompanying illustrations, which are all made from photographs taken within the last month, show no less graphically how near completion are the great masses of concrete masonry which form the locks.

Fig. 1 is a view taken from the north end of the middle locks at Gatun, looking north toward the Atlantic entrance of the canal. At the end of the lock chamber is shown the temporary coffer-dam erected to keep the locks dry while the approach channel below was flooded to permit its excavation by hydraulic dredges, this being the most economical method. Under the cableways shown in this view is the site of the famous earth slides which gave so much trouble in excavating for the lock foundations and were the cause of numerous newspaper scareheads questioning the possibility of building the locks at all.

Fig. 2 shows the lower and middle chambers of the east locks at Gatun. On the left wall is the track with the center rack partly in place, by which the electric towing locomotives, described in our issue of Mar. 21, will climb from one level to the next.

Figs. 3 and 4 are views of the Pedro Miguel locks. Fig. 4 shows a pair of the huge steel gates under erection, and Fig. 3 shows the construction of the side walls at the entrance to the lock chambers on the Pacific side. Over these 80-ft. reinforced-concrete arches will be the tracks carrying the towing locomotives out on the approach walls, where they will pick up their tows. Under the arch in the foreground is the outlet culvert for emptying the lock chamber into the waters of Miraflores Lake. Under the upper arch is the recess into which the gate shuts when the lock is open.

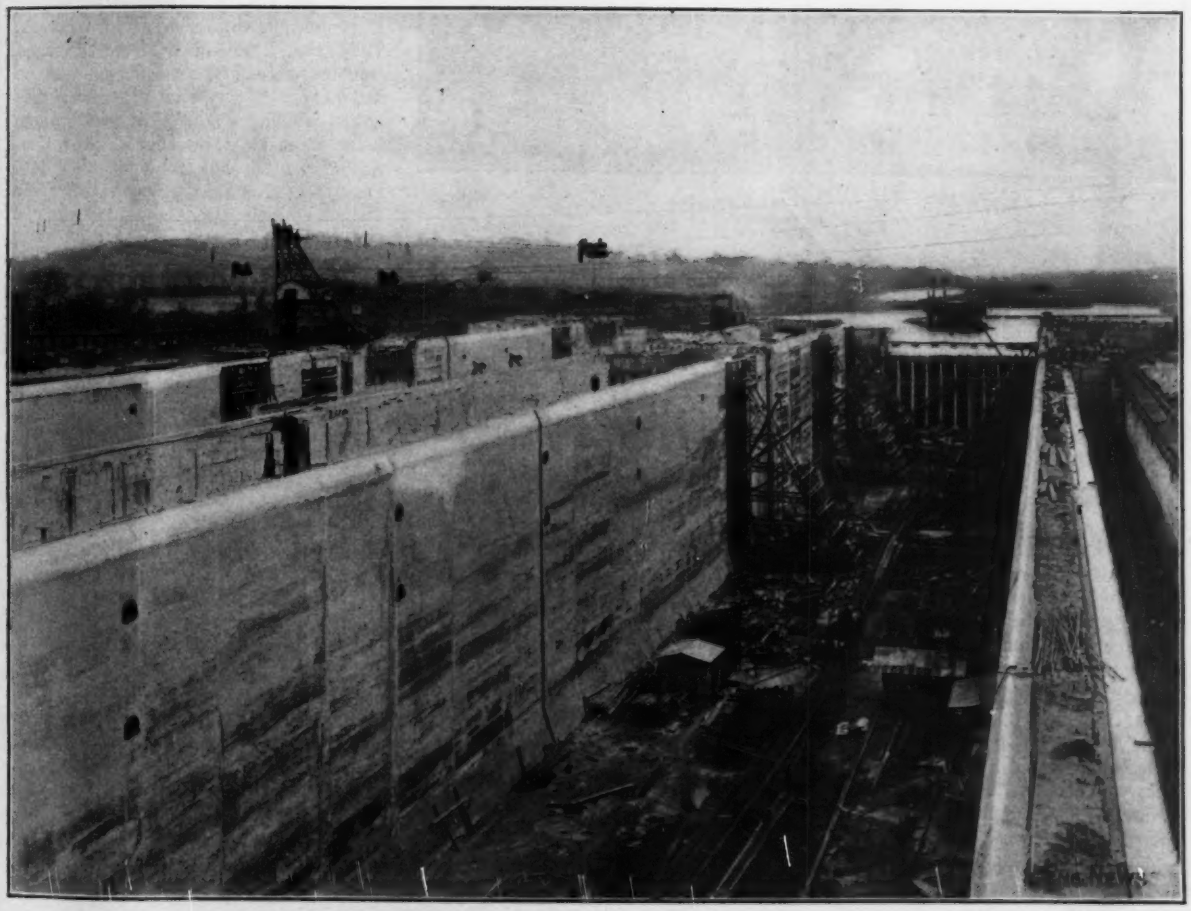


FIG. 1. VIEW OF THE LOWER LOCKS AT GATUN; LOOKING NORTH TOWARD ATLANTIC ENTRANCE
(Photograph by Underwood & Underwood, N. Y.)

Acetylene Welding and Welding Schools in Europe*

By J. M. Morehead†

In Germany there are 63 oxygen plants and one manufacturer supplying oxygen in large quantities. In a great many places they are now using oxyacetylene welding to the exclusion of all other means of metal welding.

Fig. 2. View of Lower and Middle East Lock Chamber at Gatun, Showing Track in Place for Towing Locomotives
(Photograph by Underwood & Underwood, N. Y.)

I might mention some of the uses the Germans make of it. They use the process in making case knives. Instead of making the handle solid, they make it in two pieces, and then weld them together, inserting the blade at the same time. They make bayonets for the German army. The scabbards for the swords are all welded together with acetylene. They first stamp them out in two pieces and then weld the two sides together into a single piece. They use acetylene for welding barrel hoops together. I went to one factory where they were making ladders for cleaning windows, out of bicycle tubing.

They make sleds for children. They use the automatic machine, and a great deal of the work is done by women. The article to be welded is placed in the machine, the machine is started, and the welding is done automatically. A small manufacturer of that sort makes door knobs. These door knobs are first stamped out in two pieces, and then placed in the machine and welded togtther. They also use acetylene welding in making wagon parts. They stamp out the two sides of the article and then weld them together. There is a great field for this class of work, and I believe that if it was introduced on this side, the wagon manufacturers would use it, also the automobile industry.

Then they use oxyacetylene for heavy work in ship repairing, especially in Germany and England, where they have so much marine repairing. It is more convenient than any other process. They can get the apparatus right down into the ship. On a vessel which came in there they did some work at a cost of $30,000 which on this side, by other means, would have cost a half a million dollars and would have detained the vessel in port indefinitely. The skill of the men is something wonderful. They go right into a boiler and cut and patch up a flue. One of these men will crawl into a hole so small that he can scarcely get through, and, lying on his back, will weld up a tube. Otherwise, the entire flue would have to be taken out.

Then they are much further along in aluminum work than we are in this country; also in copper welding. They can weld glass. About the last thing they show you at the school in Cologne is the glass welding. They take a piece of glass and break it, and then weld it up. Where the weld is you cannot see anything. On the sides of the weld there is a little wave as in ordinary window glass.

The biggest concern in England is now laying out a boiler-making establishment in connection with their acetylene work. They said that one of the principal troubles was that people do not want to make two contracts, and this concern has gotten together a half million dollars and a lot of space on the outskirts of London for a big boiler-making establishment, so that they can cover the whole business—both the manufacturing and the repairing.

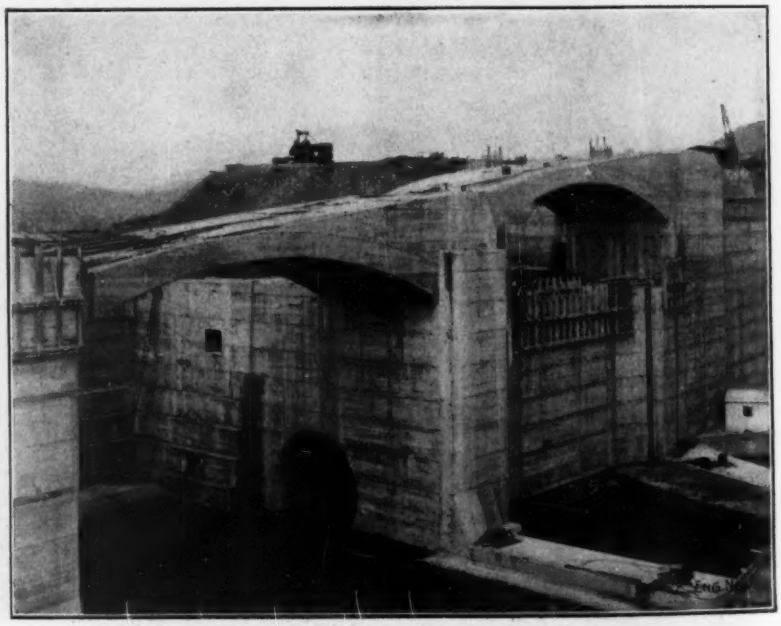


Fig. 3. Reinforced-Concrete Arches Carrying Tracks for Towing Locomotives; Pedro Miguel Locks
(Photograph by Underwood & Underwood, N. Y.)

*Abstract of address before the International Acetylene Association.

†People's Gas Bldg., Chicago, Ill.

Welding Schools

In regard to the schools for instruction in this branch of metal working, there is a large school in England in which men are trained to work with the acetylene torch. This school devotes itself more particularly to the handling of heavy repair and construction work, especially the lines related to marine engine and boiler repairs. So great is the demand for men schooled in the use of the torch that manufacturing companies are willing to send their employees to this school, and while not only paying for the time and expenses of the men, pay $10 a day to those giving the instructions. The number of applicants for this instruction is much larger than the capacity of the school and they have a waiting list of several hundred. The course takes from two to six weeks, though usually it is completed in about 30 days.

In France there is one large school with a capacity of 150 students. This school takes in a class of this number every three months. The course takes from six weeks to two months, and the school is always filled.

In Germany a very large school is maintained in Cologne. This school is maintained by an association of between 400 and 500 concerns interested in acetylene welding in its various branches and is conducted under government auspices at the Royal School for Machine Building in Cologne. The German government maintains 16 technical colleges in the different states of the German Empire, and during last March the Department of the Interior ordered the principals of these 16 technical colleges to take the course in acetylene welding at the school in Cologne, and to incorporate this course in welding in the curriculum of their respective schools. This will make 17 schools in Germany, all under government inspection and patronage, that are teaching this science and art in the usual thorough method of the German government.

These schools in Germany embrace the use and operation of the different types of acetylene generators, the generation of oxygen by different processes and a series of lectures on the chemical and physical nature of the gases worked with and the metals. Work on the practical side of the course embraces the welding of cast iron, wrought iron, steel, aluminum, copper, brass and glass. This course takes from three weeks to as many months, and, to students nominated by any company belonging to the association, the cost is but $5 for the entire course. The difference between this nominal sum and the cost of the course is borne jointly by the government and the Association of Acetylene Industries.

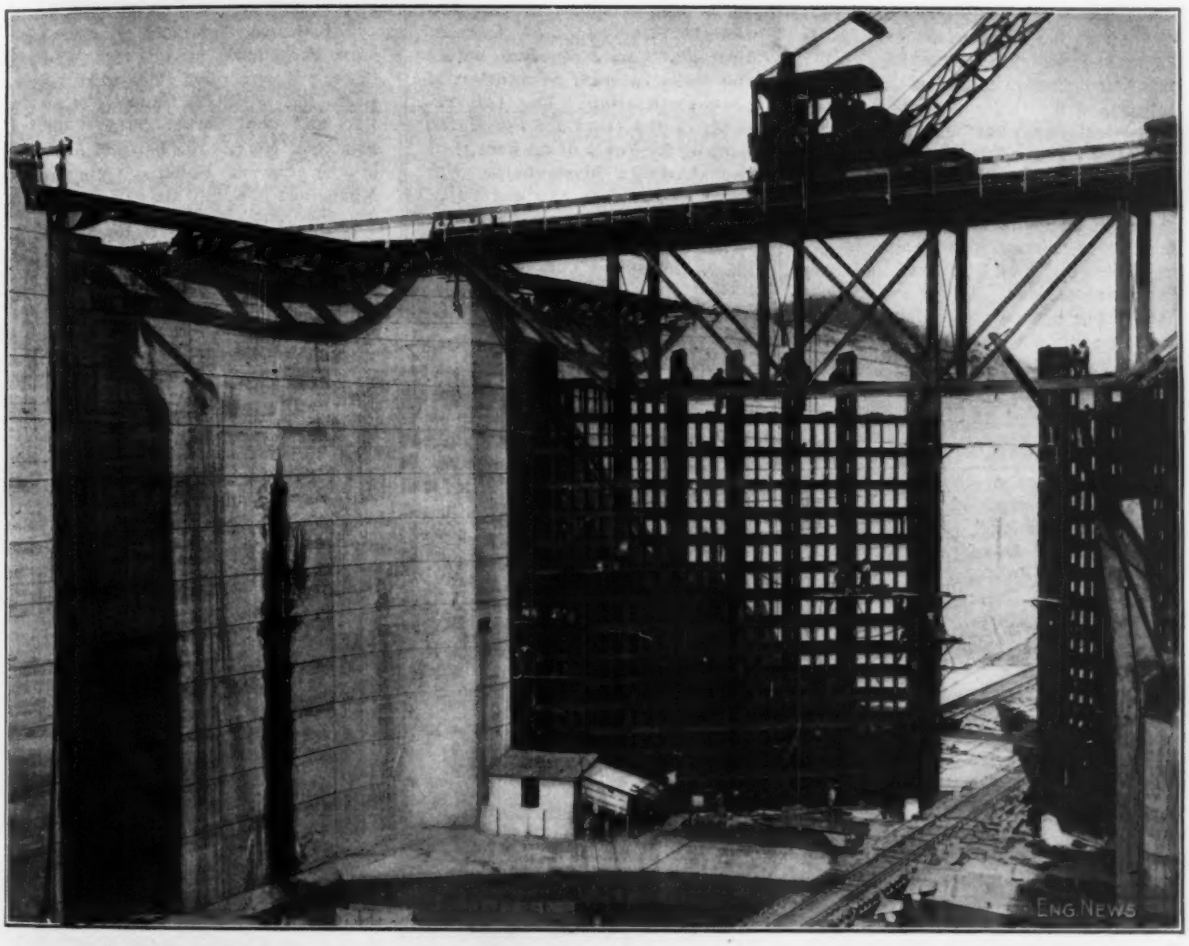


Fig. 4. Erecting the Middle Gates of the Pedro Miguel Locks; Photograph Taken on Mar. 8
(Photograph by Underwood & Underwood, N. Y.)

State Wireless Telegraphy is to be established in Austria. The minister of commerce has established a wireless telegraph bureau in Trieste and will control the operation of wireless plants on ships in connection therewith (Zeitschrift des Oesterreichischen Ingenieur u. Architekten Vereines, Mar. 15, 1912).

Elastic Deformation Tests on Reinforced-Concrete Buildings

During the past year six reinforced-concrete buildings and one full-sized test panel have been tested for the elastic deformation of the concrete and the steel under increasing loads. Four of these tests were made under the auspices of the National Association of Cement Users, and were reported before the recent annual convention of that association. The full records of the tests are much too lengthy for publication here, but the abstracts given below will serve to indicate the nature of the work and particularly its value in the study of the behavior of reinforced concrete under load.

At the recent annual convention of the National Association of Cement Users (Kansas City, Mo., Mar. 11-16, 1912) the Committee on Reinforced Concrete and Building Laws* presented as its report an account of four separate tests in investigation of the elastic deformation of reinforced-concrete buildings under load. These tests were made during the year 1911 under the supervision of the committee and with the coöperation of the Experiment Station of the University of Illinois and the research departments of the several contractors of the buildings under test. The report when printed will cover some 70 or 80 pages of the *Proceedings* of the Association and will contain from 50 to 60 diagrams and other illustrations, so that it is manifestly impracticable that they be printed in full in ENGINEERING NEWS. In order that they may be put before our readers now instead of some six or eight months hereafter, when the *Proceedings* will appear, we have made a resumé of the tests with their results, which we print below.

NATURE OF THE TESTS

The tests were of the same general type as the one reported by H. B. Lord before the National Association of Cement Users in its convention last year and reprinted in ENGINEERING NEWS, Dec. 22, 1910, p. 697. Since Mr. Lord's test the instruments used have been much improved and the technique of the testing brought to a higher degree of accuracy, but the fundamental methods are the same. They consist in loading with an increasing load a number of consecutive panels of a reinforced-concrete building in age varying from fifty days to one year and of observing by means of delicate instruments the exact contraction or expansion of certain portions of the reinforcing steel and of the structural concrete. These observations are made by removing in given places the concrete from the steel and placing thereon small drill holes in which the extensometer points may be placed and also by drilling small holes in the concrete for the same purpose. At the same time fixed points are placed upon the bottoms of such beams and slabs and the deflection under load measured by means of extensometers based on stationary stagings or platforms rising from the floor below.

On account of the very small deformation in the material it is necessary to use the greatest care in the manipulation of instruments so that a reasonable accuracy in purely instrumental readings may be attained. At the same time temperature observations must be kept so that adjustments for expansions of the instrument and of the structural material may be made. An experienced force was used in all of the work and it is a matter of observation that the accuracy of the last made test was much higher than in the first.

From the elastic deformations so obtained and from values for moduli of elasticity of the steel and concrete variously obtained, as noted in the specific tests below, the stresses in the members investigated may be computed and the values obtained compared with those for which the building is designed. Such comparisons are subject to many reservations on account of the methods of observation and particularly of the methods of original design. The committee has not prepared any complete summary of results, nor does it intend to until more tests have been undertaken. Such comparisons and further deductions regarding the proper design of reinforced concrete must await a more complete investigation of the data obtained.

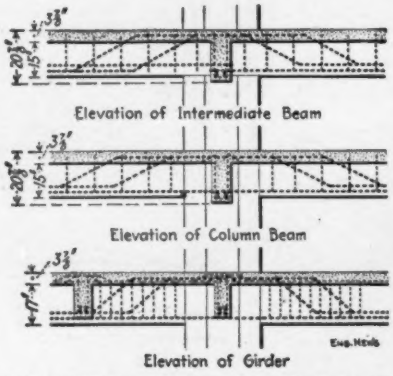


FIG. 1. WENALDEN BUILDING. DETAILS OF BEAM AND GIRDER REINFORCEMENT

The tests described in the report comprised two on a so called standard form of beam and girder reinforced-concrete construction, one on a girderless or flat-slab floor, and one on a floor of the so called two-way tile and concrete type, made particularly for this test. The two beam and girder buildings were respectively the Wenalden Building, Chicago, Ill., and the Turner-Carter Building, Brooklyn, N. Y. The flat-slab floor was in the Powers Building, Minneapolis, Minn., and the full sized two-way slab test floor was an independent panel.

THE WENALDEN BUILDING TEST

The Wenalden Building is a 10-story reinforced-concrete structure of the typical beam and girder type with floor panels 15x20 ft. The girders are placed between columns in the short direction and floor beams extend the long way of the panel, there being two intermediate beams built into and supported by the girders and a column beam built into and supported by the columns. The floor, 3⅞ in. thick, including the top finish, was built continuously with beams and girders. The general type of the reinforcement is shown in Fig. 1. As will be noted there, the main reinforcing bars (twisted bars) are carried along the bottom of the beam from the end of the panel to a point beyond the middle of the panel where they are bent up to the top of the beam and carried horizontally to a corresponding point on the other side of the support, then bent down and continued along the bottom of the beam to the end of the next panel. These reinforcing bars are carried the length of two panels. In the intermediate beams at the bottom and middle there are four rods ¾ in. square and in the side beams one rod ¾ in. square and three rods ⅝ in. square. In the girders there are four rods ⅞ in. square, the disposition of which is similar to that in the beams. By this plan there is twice as much of the main reinforcing steel in the bottom of the beam or girder at the middle of the span as there is at the top over the supports, except that four ⅜-in. square rods placed in the floor slab are also available for end reinforcement of the intermediate beams. The beams are 6¼ in. wide and the girders 7½ in.

The concrete was composed of 1 part portland cement, 2 parts torpedo sand, and 4 parts crushed limestone. Although the building was not fully completed when the test was made, the floor tested had been built more than 12 months be-

*The committee is composed of A. E. Lindau (Buffalo, N. Y.), chairman, and W. P. Anderson, E. J. Moore, Arthur N. Talbot and S. E. Thompson.

fore the time of the test. The work of cutting the floor and beams for inserting points of measurement proved to be very difficult and showed the concrete to be very hard and of excellent quality.

test. A single panel *B*, Fig. 2, was first loaded from 80 to 400 lb. per sq.ft., in increments of 80 lb. per sq.ft. The load was then removed. The load was then applied on three panels in tandem *ABC*,

sults of observations for various gage lines are plotted in Figs. 4, 5 and 6. From a study of these it is readily seen that there are irregularities in the measurements and that the general trend of

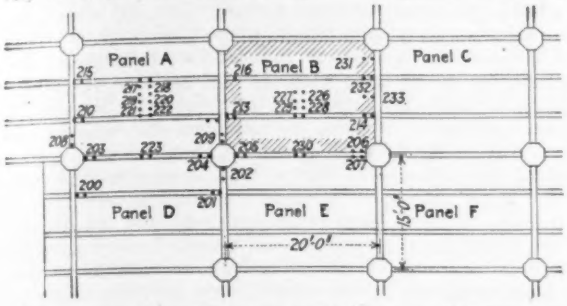


FIG. 2. WENALDEN BUILDING. GAGE LINES ON TOP SURFACE OF FLOOR

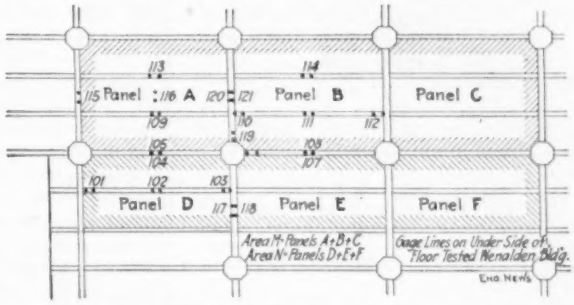


FIG. 3. WENALDEN BUILDING. GAGE LINES ON UNDER SIDE OF FLOOR

Key to gage points: Even numbers steel gage points; odd numbers concrete gage points. 100-199 on under side, 200-299 on upper side of floor.

The test was made on the first floor, the only one which could be reached with the loading material. The space chosen was one freest from openings and other irregularities of construction. The floor was designed for a live load of 200 lb. per sq.ft. and the test load was made 400 lb. per sq.ft. over panels loaded. The loading was done by piling brick and bags of cement in piers separated by aisles in such a way as to give access for points of measurements and to prevent arching effects influencing the tests.

The following is the general plan of the

Fig. 3, again in increments up to 400 lb. These three panels are termed area *M* in the load-deformation diagrams. Then leaving this load on, a load, increasing also up to 400 lb., was applied along three adjacent panels *DEF* covering two-thirds of the width and making in all the equivalent of five loaded panels. This portion of these three panels is termed area *N* in the load-deformation diagrams. The load was then taken off by increments.

The key to the gage point numbers is given under Figs. 2 and 3.

Deformations and Stresses—The re-

some of the lines must be taken rather than absolute values.

In translating from unit-deformation to unit-stress the modulus of elasticity of steel has been taken at 30,000,000 lb. per sq.in. and that of the concrete has been assumed to be 3,000,000 lb. per sq.in. For simplicity the straight-line stress-deformation relation for concrete has been assumed, though it is evident that this relation does not hold for the higher stresses and that calculated stresses based upon this assumption are in excess of the actual stress.

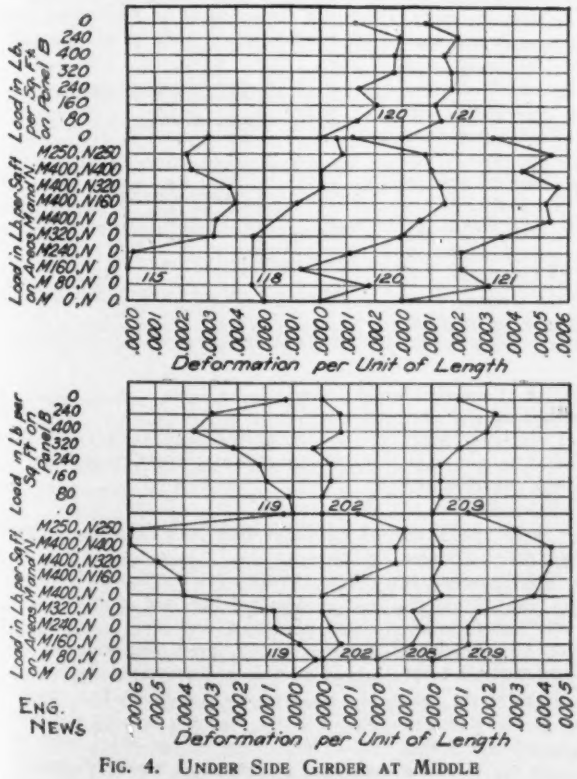


FIG. 4. UNDER SIDE GIRDER AT MIDDLE
FIG. 5. END OF GIRDER

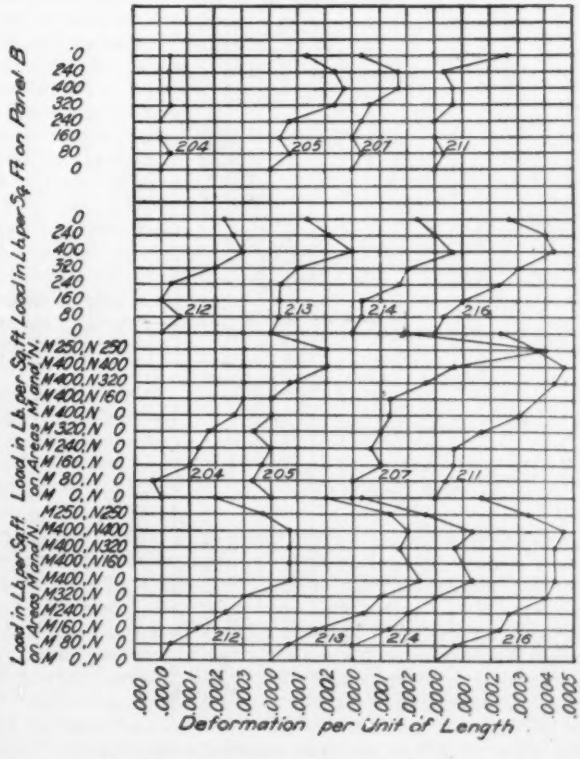


FIG. 6. UPPER SIDE OF BEAMS AT END

FIGS. 4-6. WENALDEN BUILDING. LOAD DEFORMATION DIAGRAMS

TABLE I.* MAXIMUM STRESSES AND MOMENT COEFFICIENTS IN WENALDEN BUILDING TEST

Member	Reinforcement Stress	Reinforcement Coefficient	Concrete Stress	Concrete Coefficient
Girder:				
End. Design..	44,000	0.083	1,700	0.083
End. Test.....	13,000	0.024	2,200	0.106
Middle. Design	19,000	0.083	420	0.083
Middle. Test...	17,000	0.075	.....	.....
Intermediate beam:				
End. Design..	36,000	0.083	1,900	0.083
End. Test.....	16,000	0.037	2,000	0.088
Middle. Design	22,000	0.083	440	0.083
Middle. Test...	16,000	0.06	.....	.....
Column beam:				
End. Design..	69,000	0.083	.....	.....
End. Test.....	13,000	0.018	.....	.....
Middle. Design	26,000	0.083	.....	.....
Middle. Test...	11,000	0.035	.....	.....

*This is the corrected table and not the one presented to the Convention, which was incorrect in some particulars.

The stresses under various conditions of load may be thus calculated from the above assumptions and observations. They are not given in detail in the report, but, Table I shows a comparison of the maximum stresses obtained by this method with the analogous stresses obtained under the theory of design. The first line of each set gives the calculated stresses in the reinforcement and in the concrete based upon the value of the bending moment quite commonly assumed in design calculations, 1/12 *Wl*, where *W* is the total distributed load on the beam and *l* is the span length. In these cases the span length was taken as 3 in. longer than the clear span. Measurements had been made upon the position of the bars and the depth of the reinforcement, which were not always exactly according to the plans, and the calculations have been based upon the dimensions found. In the second line of each group the maximum

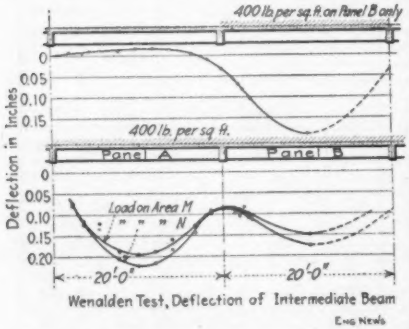


FIG. 7. WENALDEN BUILDING. DIAGRAM SHOWING DEFLECTIONS

stress obtained by the measurements is given in the column of stresses, and the bending moment coefficient (the coefficient of *Wl*) corresponding to these stresses is recorded in the adjacent column. In these calculations the common assumptions of design calculations (including the neglect of the tensile strength of the concrete) are followed except that the width of T-beam is taken as equal to the distance from center to center of beams. In calculating the bending moment coefficient from the measured stress, the position of the neutral axis and the value of the moment arm are assumed to be the same as given by the ordinary assumptions. Although the stress in the reinforcement is measured at the surface of a bar of the outer layer, this stress is considered as being the same as that acting at the center of gravity of the group of bars, for the actual variation in the group is unknown and this method will give a bending moment coefficient larger than that found by considering that the stress in the bars of the other layer is smaller. In the calculation for compressive stresses, the compression reinforcement was considered to take its proportion of compressive stress, though there may be a question whether the embedment in such designs is sufficient to insure this condition.

In the tests with three and five panels loaded the highest stress observed in the reinforcement in the middle of the intermediate beams was 16,000 lb. per sq.in. and the highest stress observed at the ends of the beams was 16,000 lb. per sq.in. The stresses observed in bars having similar positions were lower, and probably the highest stress is not representative of the general stresses. However, it may be best to compare on the basis of the highest stresses. The bending moment given in the table as derived from the measured stresses is 0.06 *Wl* at the middle of the beam and 0.037 at the end of the beam. Measurement of the compression of the concrete in this test was less satisfactory than the measurement of the reinforcement deformations, and considerable variation was found at the different points of observation. Not enough gage lines gave satisfactory measurements to warrant making quantitative conclusions, but the indications of the action of the concrete may be useful. The value of the resisting moment which corresponds to the concrete stresses, on the assumptions made, is 0.088 *Wl* for the end of the beam. For the middle of the beam the stresses were so small and the indications so irregular that no value of resisting moment can be given.

In the beams at the sides of the panel (column beams) the stresses were in general somewhat lower, but with a full loading a steel stress of 15,000 lb. per sq.in. at the end of the beam was observed and 11,000 lb. per sq.in. at the middle.

Fewer measurements were made on the reinforcement of the girder. A stress of 17,000 lb. per sq.in. was observed at the middle of the girder and 13,000 lb. per sq.in. at the end. On the same assumptions these values correspond to bending moments of 0.075 *Wl* and 0.024 *Wl*, respectively. The stress in the concrete at the end of the girder was also very high, but the corresponding resisting moment (0.106 *Wl*) is not far from the calculated moment for a restrained beam with concentrated load.

Calculating with the usual assumptions of beam formulas, the total compressive stress in the concrete at the end of the beam is greater than the total tensile stress in the reinforcement. Two elements probably enter into the results, the tensile strength of concrete which may be considerable as distributed over the width of the floor, and an arching action of the structure. However, it should be noted that the value of the bending moment coefficient derived from the reinforcement stresses at the middle of the beams and girder is not much less than values commonly used and also that the calculated resisting moment developed at the end of the beam based on the concrete stresses is not far from the amount usually assumed.

Attention should be called to the fact that the compressive stress in the concrete, both that calculated from an assumed bending moment and that calculated from the measured deformation, is much higher than that to be found by the use of the parabolic stress deformation and the actual stress will be less than that given in the table.

Measurements were made on the concrete at the top of the floor slabs in a direction parallel with the beams to find the distribution of compressive stresses between beams. These measurements were not fully satisfactory, but within the limits of accuracy of the measurements, no difference in the amount of shortening over the beam and at points between beams could be determined and the whole floor evidently acted as a part

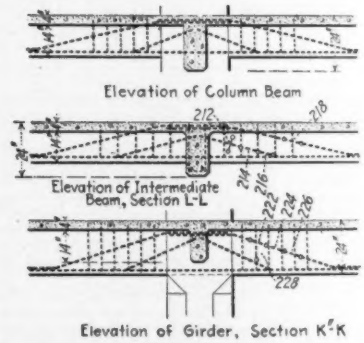


FIG. 8. TURNER-CARTER BUILDING. DETAILS OF BEAM AND GIRDER REINFORCEMENT

of the compression member of the T-beam so formed.

Test Cracks—The surface of the beam and girder had received a white coat, which permitted very fine cracks to be detected, much finer than may be observed on uncoated concrete. In the test, as the load was applied, fine tension cracks in the concrete through the middle of the length of the beam were observable at stresses in the reinforcement corresponding to the stresses at which load cracks are detected in the tests of

beams in laboratory work. To an experienced observer development of the cracks was confirmation of the measurements of the low stresses developed in the reinforcement. Upon removal of load most of these cracks closed until they were not visible to the eye.

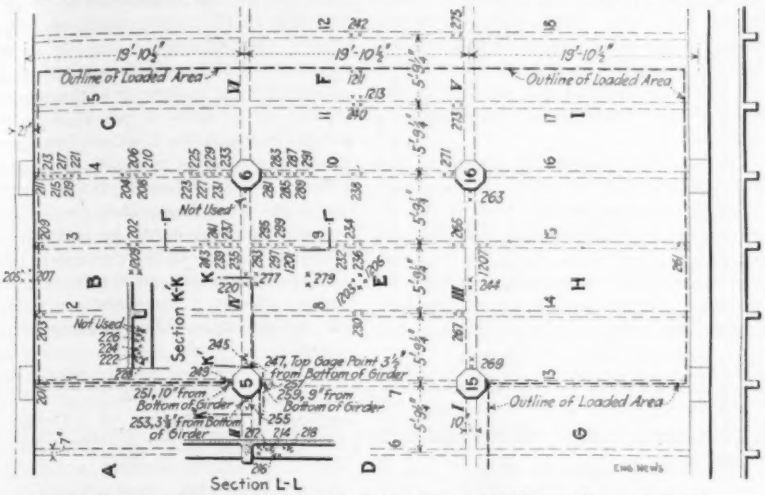

Outline of Loaded Area
Outline of Loaded Area
Outline of Loaded Area
Not Used
Not Used
Section K-K
247, Top Gage Point 3½ from Bottom of Girder
251, 10" from Bottom of Girder
259, 9" from Bottom of Girder
253, 3⅜ from Bottom of Girder
Outline of Loaded Area
Section L-L

FIG. 9. TURNER-CARTER BUILDING. GAGE LINES ON UNDER SIDE OF FLOOR
Key: Odd numbers concrete, even numbers steel gage points. 200-299 on under side of floor.

As the calculated reaction on the end of a girder was upward of 40,000 lb., it will be seen that the vertical shearing stresses were very high. Diagonal tension cracks developed in these girders just outside the junction with the intermediate beams, making an angle of nearly 45° with the horizontal. These cracks did not entirely close on the removal of the load. No measurements were taken to determine the diagonal deformations. It seems probable that the restraint at the end of the girder and the tensile strength of the concrete acted to prevent the fuller development of these cracks.

No diagonal cracks were observed in the beams.

Deflections—Fig. 7 shows the deflections with a load of 400 lb. per sq.ft. for points along an intermediate beam, (1) with one panel loaded and (2) with three panels loaded, and (3) with five panels loaded. As may be expected, the deflection in the middle panel was greater for one panel loaded than when three panels were loaded.

TURNER-CARTER BUILDING

In the preceding test record the diagrams given in the original report were reproduced very fully, so as to illustrate to our readers the method of recording the data obtained. It is impossible that this reproduction be carried out so fully in the remaining tests, which will be described only in general, with a summary of the deductions in each case.

The Turner-Carter building is an eight-story reinforced-concrete building 60x200 ft., located in Brooklyn, N. Y. The building is of the beam and girder type. The panels are 17 ft. 4 in. by 19 ft. 6 in. The floor was built continuously with the beams and girders. The girders are 10 in. wide and 24 in. deep, including the finished floor. Each panel has two intermediate beams 7 in. wide with a total depth of 18 in. The column beams are the same as the intermediate beams. The columns below the test floor were 30 in. from face to face. The position of reinforcement of the beams and girders is shown in Fig. 8. The beams and girders were designed as simple beams, but reinforcement is supplied for continuity, and the construction was such as to give continuity in the beams and girders. The structure was designed for a live load of 150 lb. per sq.ft.

The aggregates were an excellent grade of sand and gravel. For the beam and girder reinforcement, bars having an elastic limit of about 50,000 lb. per sq.in. were used. The beams have one 1-in. square bar and two ⅞-in. square bars at the middle and one 1-in. square bar over the support carried about 15 in. beyond the center line of the girder. Ten ⅜-in. round bars placed in the slab are also available for tension reinforcement in the end of the intermediate beams, as is also one T-bar used for supporting the slab reinforcement during construction. The girders have two 1-in. square and three ⅞-in. square bars at the middle, placed in two layers, and two 1-in. square bars over the support carried nearly to the farther face of the column.

The floor was tested when the work was about 50 days old.

The most important determinations taken up in the test were the measurement of the compressive deformations in the concrete at and near the supports of the beams, the compressive deformations of the concrete at the middle of the beam, and the distribution of these compressive stresses across the top of the slab between beams to determine the extent of T-beam action. The deformation in the reinforcement was measured at the center of the spans and at the end and also on the inclined portions of the bent-up bars. Various other measurements which it was thought would throw light upon the action of the structure were taken.

The test area was on the third floor. The loading material was damp sand which was placed in bottomless boxes. These boxes were of various sizes and were placed in such a way as to give a well distributed load. The general size of the box was 4 ft. 6 in. wide, 8 ft. long and 4 ft. 6 in. deep. The boxes were made small enough to permit a good distribution of load even though part of the

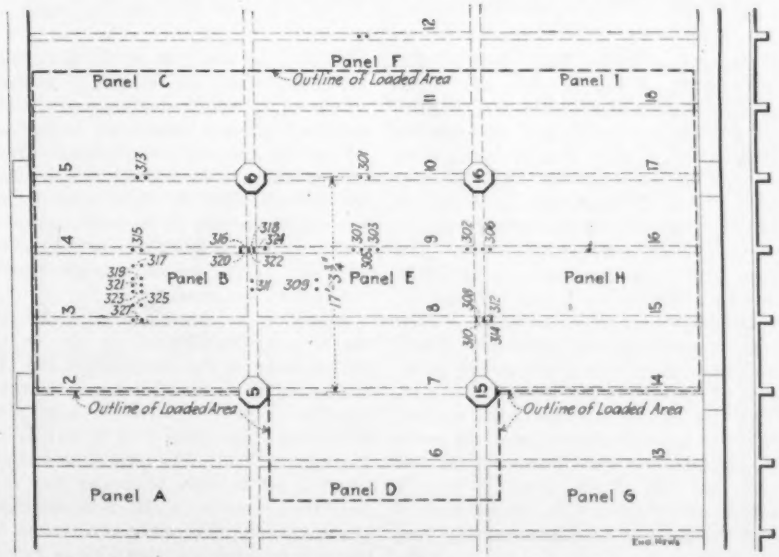


FIG. 10. TURNER-CARTER BUILDING. GAGE LINES ON UPPER SIDE OF FLOOR
Key: Odd numbers concrete; even numbers steel gage points. 300-399 on upper side of floor.

TABLE II.* TURNER-CARTER BUILDING TEST. MAXIMUM STRESSES AND MOMENT COEFFICIENTS

Member	Reinforcement Stress	Reinforcement Coefficient	Concrete Stress	Concrete Coefficient
Girder:				
End. Design..	31,000	0.083	1,200	0.083
End. Test.....	.....	.....	900	0.06
Middle. Design	12,500	0.083	300	0.083
Middle. Test...	8,000	0.05	Little	.....
Intermediate beam:				
End. Design...	21,500	0.083	1,300	0.083
End. Test.....	8,000	0.03	1,100	0.07
Middle. Design	18,500	0.083	380	0.083
Middle. Test...	11,000	0.05	350	0.077
Column beam:				
End. Design...	19,600	0.083	1,200	0.083
End. Test.....	.....	.....	950	0.064
Middle. Design	17,000	0.083	350	0.083
Middle. Test..:	10,000	0.05	225	0.054

*Corrected table.

weight of the sand might be carried by arching and friction down the sides. The test area covered three full panels and parts of four others, in all equivalent to five panels. A loading space was chosen which it was thought would give the fullest stresses over the girders and beams on which the principal measurements were made. In removing the load the outer panels were unloaded first in an attempt to determine the relation between single-panel loading and group loading. The load applied was the equivalent of 300 lb. per sq.ft., double the design live load.

Readings were taken immediately after the completion of each increment of load and again immediately before the beginning of placing another increment of load. This usually corresponded with evening readings and morning readings. A series of readings was also taken with the full test load on. These extended over a period of 48 hours. A similar method was also used in the process of removing the load.

The load was applied in increments of 100 lb. per sq.ft. based upon the whole test area. The application of the load consumed three days. The full load was left on 48 hours. In the unloading, the load on panels *B* and *C* were first removed, then the load on panels *D*, *F* and *I*, followed by the removal of the load on panel *H*.

The original report is accompanied by 11 diagrams, similar in form to Figs. 4-6, herewith, giving the load-deformation curves for the various gage points on concrete and steel. From these deformations, by the same method as is described for the Wenalden building above, a series of maximum stresses and moment coefficients was obtained, as reproduced in Table II.

Beams—For the tensile stresses in the reinforcement at the middle of the intermediate beams at the full load of 300 lb. per sq.ft., the highest stress observed was 11,000 lb. per sq.in. and the average stress recorded may be said to be 8500 lb. per sq.in. At the end of the intermediate beams, the highest stress observed in the reinforcement was 8000 lb. per sq.in., and the general value may be said to be 7500 lb. per sq.in. Using the assumptions for resisting moment ordinarily taken in design calculations, these stresses may be considered to correspond to a bending coefficient of 0.05 *Wl* for the maximum stress at the middle of the beam and 0.03 *Wl* for the maximum stress at the end of the beam, if the tensile strength of the concrete be not considered.

Assuming a modulus of elasticity for the concrete of 2,500,000 lb. per sq.in., the concrete on the compression side of the beams at the middle showed a compressive stress of 350 lb. per sq.in. and at the end of the beam 1100 lb. per sq.in. It is apparent that the total compressive stress in the concrete is greater than the total tensile stress in the reinforcement of the beams. A possible explanation is that end thrust exists, involving so called arch action in the beams and floor structure, and that the tensile stress is relieved by the presence of this thrust. The tensile strength of the concrete must have a large effect on the resisting moment. The coefficient of *Wl* in the bending moment, necessary to give a compressive stress equal to the maximum measured in the concrete, on the assumptions made, is 0.077 for the middle of the beam and 0.07 for the end of the beam, again neglecting the tensile strength of the concrete. These coefficients are lower than the value 1/12 usually assumed in design of such beams.

Girders—For the tensile stresses at the middle of the girders the observations showed about 8000 lb. per sq.in. in the reinforcement at the middle. This corresponds to a bending moment coefficient of 0.06. The reinforcement at the end of the girder was inaccessible.

Assuming a modulus of elasticity of 2,500,000 lb. per sq.in., the concrete on the compressive side of the beam at the support showed a compressive stress of 900 lb. per sq.in. The reading at the middle of the beam showed very little compression. Assuming that the loads on the girder are concentrated at the points where the intermediate beams are connected, and making the same assumptions of distribution of stress as before, the coefficient of bending moment was 0.05. It seems probable that the compression at the middle of the span must be distributed a considerable width of floor, or larger readings of compression would have been obtained.

Decrease in Compression with Distance from Support—In four beams, measurements of compressive deformations were taken at a series of gage lines from the support to a location near the point of inflection at locations where it may be expected that there will be full restraint for the end of the beams. The unit-deformations for these gage lines at loads of 200 lb. per sq.ft. and 300 lb. per sq.ft. are plotted in Figs. 11-12.

The measurements recorded for the column beams show considerably more compressive stress than do those for the intermediate beams, perhaps one-third more. This difference in stress may be due partly to the deflection of the girder,

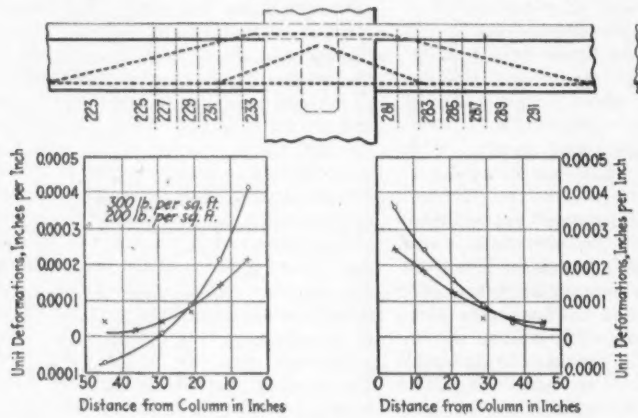


FIG. 11. TURNER-CARTER BUILDING. DIAGRAMS SHOWING DISTRIBUTION OF COMPRESSIVE DEFORMATION IN BOTTOM OF COLUMN BEAM

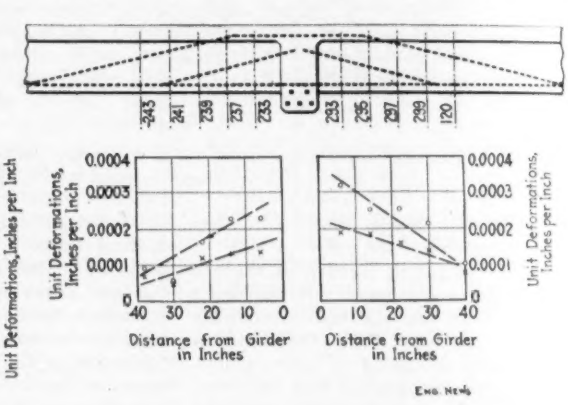


FIG. 12. TURNER-CARTER BUILDING. DIAGRAM SHOWING DISTRIBUTION OF COMPRESSIVE DEFORMATION IN INTERMEDIATE BEAM

and to the deflection of the intermediate beam between its support and a point opposite the end of the column beam, which would permit a larger part of the load to be carried by the column beam. It may be due somewhat to the fact that reinforcing bars are bent down from a point at the end of the column beam, while in the intermediate beams the bars run horizontally for a foot from the face of the girder.

The direction of the lines in Fig. 11 and Fig. 12 indicates a zero stress at about 45 in. from the face of the column in the column beams and at about 50 in. from the face of the girder in the intermediate beams. In both cases the results locate the point of inflection at about 0.22 of the clear span.

T-Beam Action—The distribution of compressive stresses in the T-beam formed by a beam and the floor slab (which involves the distances away from the beam for which compressive stresses are developed) has been a fruitful source of discussion. Measurements parallel to the axis of the beam were taken on the upper surface of the floor slab imme-

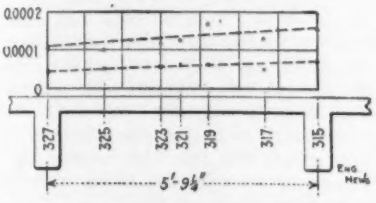


FIG. 13. TURNER-CARTER BUILDING. DIAGRAM SHOWING DISTRIBUTION OF COMPRESSIVE DEFORMATION ACROSS FLANGE OF BEAM

diately above beams and at intervals between them. The amount of these deformations at points across the slab for loads of 200 lb. and 300 lb. per sq.ft. is shown in Fig. 13. It is apparent that a somewhat higher stress existed in one beam than in the other. Taking this into consideration, the compressive stress varies quite uniformly from one beam to the other, and the full width of the floor slab may be said to be effective in taking compression. The overhang (counting to the midpoint between beams) is 6½ times the thickness of slab. It will be noticed that the conclusions are the same as given for the Wenalden building test.

Measurements were taken on the floor slab in the direction of its span at three places on the under side and at one place on the upper side immediately above one of the lower measurements. All stresses found there were low.

An attempt was made to measure the movement, relative to each other and to the concrete, of the overlapped tension bars at the ends of the beams, where they enter the girder, but the results were not very satisfactory. They are, however, recorded in the report. The same may be

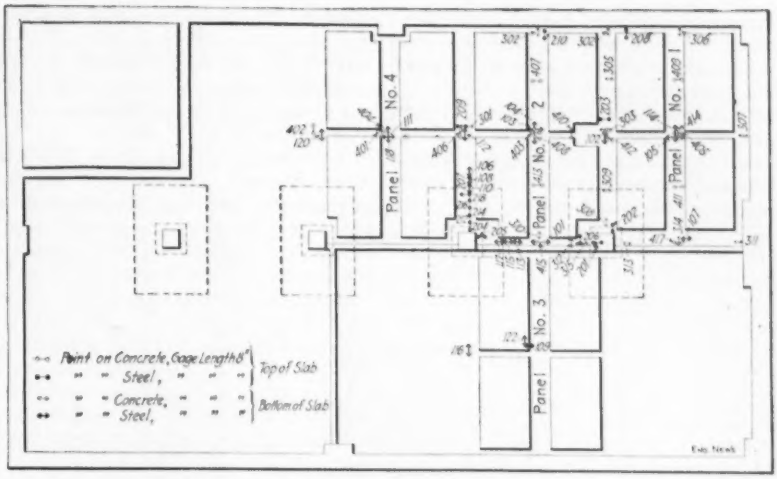


FIG. 14. POWERS BUILDING. LOCATION OF GAGE POINTS

said of the web stress investigation and the readings on the faces of the columns.

POWERS BUILDING TEST

The building tested was a three-story and basement warehouse with exterior bearing walls and one row of columns through the middle of the building. The floors are of the flat slab type reinforced in two directions with high elastic limit deformed bars. The reinforcement comprises a right-angled mesh of rods in both upper and lower planes of the floor over the columns, with a supported slab reinforced with rods in both directions parallel to the column lines. The drawings furnished by the report do not give a very clear idea of the disposition of this reinforcement, so they are not reproduced here.

The first floor of the building was selected for the test by the Building Inspector of the City of Minneapolis, as he required an acceptance test to be made. At the time of the test this floor was about three months old. Progressive loading from 50 lb. per sq.ft. to 400 lb. per sq.ft. was made over the four panels indicated in Fig. 14.

The test continued for nine days. Readings were first taken in all points with the floor unloaded, and then a load approximately equivalent to 58 lb. per sq.ft. was applied over four panels (Fig. 14). Another set of readings was taken, and the load increased to 125 lb. per sq.ft.; this method of alternate loading and reading obtained throughout the test. When the design load of 200 lb. was reached, however, the load on panels one and four was moved by stages to panels two and three, so that finally panels one and four were completely unloaded, and panels two and three were loaded to about 400 lb. per sq.ft. The load was next removed from panel three and finally from panel two, readings being taken at intervals during the unloading.

Deflection readings were taken at 32 points and deformations of the steel were read at 30 points and of the concrete at 31 points, as shown in Fig. 14. All of these readings are given in tabular and diagrammatic form in the report, but

TABLE III. POWERS BUILDING. SUMMARY OF STRESSES IN LB. PER SQ.IN.

Location		Gage Point	Design Load (200 Lb. Sq.Ft. D.L.*	L.L.	Total	400 Lb. per Sq.Ft. L.L.	Total
Steel Stresses							
Over column head	Long span	202	2000	14,000	16,000	19,000	21,000
		204	2500	17,500	20,000	23,000	25,500
		Av.	2250	15,750	18,000	21,000	23,250
	Short span	201	1500	3,000	4,500	7,000	8,500
		205	1000	3,000	4,000	1000,	11,000
		Av.	1250	3,000	4,250	8,500	9,750
Bottom of slab at side of panel	Long span	102	1000	7,000	8,000	9,000	10,000
		112	1500	11,500	13,000	13,500	15,000
		Av.	1250	9,250	10,500	11,250	12,500
	Short span	101	500	1,000	1,500	4,000	4,500
		104	500	7,500	8,000	12,000	12,500
Bottom of slab at middle of panel	Long span	122	1000	4,000	5,000	9,500	10,500
		Av.	750	5,750	6,500	10,750	11,500
	Short span	103	500	1,500	2,000	8,000	8,500
		109	1000	2,500	3,500	6,500	7,500
		Av.	750	2,000	2,750	7,250	8,000
Concrete Stresses							
Bottom of slab at column	Long span	308	100	750	850	1,050	1,150
	Short span	315	100	250	350	450	550
Top of slab at edge of panel		406	100	300	400	350	450
	Long span	412	100	400	500	500	600
		Av.	100	350	450	425	525
Top at middle	Long span	408	150	400	550	600	750
Bottom of slab at wall	Long span	304	50	150	200	250	300
		304	100	250	350	400	500
		Av.	75	200	275	325	400

*Dead load-stresses obtained from load-stresses. Curves by projecting curve down to no-load line.

are not reproduced here. From them, unit steel and concrete stresses, figured as in the other tests, were plotted against the load per square foot.

A summary of the unit stresses is given in Table III. The stresses given in this table are the maximum probable values. The concrete stresses are based on an assumed modulus of 2,000,000.

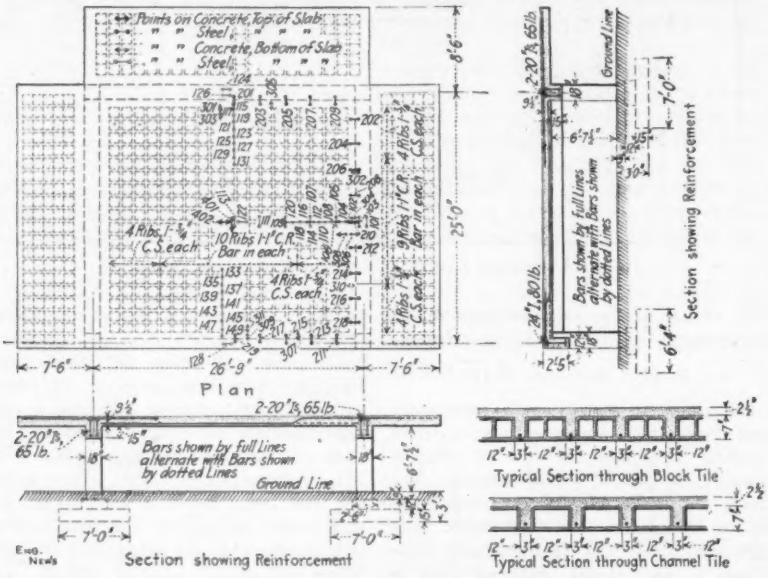

Points on Concrete, Top of Slab
" " Steel, " " "
" " Concrete, Bottom of Slab
" " Steel, " " "
Plan
Section showing Reinforcement
Typical Section through Block Tile
Typical Section through Channel Tile
Ground Line
Bars shown by full Lines alternate with Bars shown by dotted Lines

FIG. 15. TWO-WAY TEST FLOOR. GENERAL DETAILS OF CONSTRUCTION AND LOCATION OF GAGE POINTS

During the test, cracks were carefully searched for with an electric light, and recorded as found. Most of these cracks were very minute and difficult to trace, and were only of such magnitude as would be expected to accompany the steel stresses observed.

The fact that the adjoining panels assist in carrying a load placed on one panel may be assumed from the fact that deflections were observed in panels adjacent to those loaded, and by the fact that cracks on the under side of the slab were traceable well past the middle panels adjoining these loads.

The point of contraflection was found to be at 0.21 of the clear span from the edge of the column head.

Readings on one of the bars over the column cap show a bond stress of 135 lb. per sq.in. under maximum loading.

TWO-WAY TILE AND CONCRETE FLOOR

The test panel represented a wall panel of a continuous floor. To approximate existing conditions, cantilevers were built on three sides. These cantilevers were loaded during the test until the tangents to the slab over the supporting beams became approximately horizontal as they would have been in a continuous floor under multiple panel loading.

The panel proper is 25 ft. long by 26 ft. 9 in. wide, as shown in Fig. 15, and is carried by steel I-beams, fireproofed with concrete. These beams rest on steel bearing plates on concrete posts at each corner of the panel. Seven-inch tile was used with a cover of 2½-in. 1:1.5:3 concrete, making the total thickness of the slab 9½ in.

The arrangement of tile is such that when alternate rows of block tile and channel tile are laid, the concrete is formed into two series of intersecting T-beams, spaced 15 in. c. to c. each way and having 3-in. stems. Small furring tile, laid at the intersection of the ribs thus formed, complete the tile-ceiling surface.

The panel was poured under unfavorable conditions, it being necessary to carry on a considerable portion of the work after dark. The weather was very hot during the next few days, and several of them were holidays, so that the slab was not even kept wet down. On the whole, conditions under which this slab was erected were probably not more favorable than would exist on an actual building.

Sand in sacks was used for the load, each sack being filled on the scales and weighing 100 lb. The loading was progressed by stages, alternating with readings, until 650 lb. per sq.ft. was reached. The test was stopped at this point because of the expense involved in placing the load upon the high piles of sacks. The total load remained in place on the panel for 48 hours, after which unloading was started and was completed five days later.

Both steel and concrete stresses, as well as deflections, were measured throughout the test, exceptionally complete sets of readings being taken under the design load of 150 lb. per sq.ft., and under the test load required by the City of St. Louis, i.e., a superimposed load, equal to once the dead load plus twice the live load, or 380 lb. per sq.ft.

The test load required by the City of St. Louis is a superimposed load, equal to twice the live load, plus the dead load, or 380 lb. per sq.ft. for this panel. Up to this load the cantilevers were carefully loaded to horizontality, but from this stage on, no more load was applied to the cantilevers, and they rose slightly, thus increasing the deflection at the center of the panel.

The horizontality of the tangents over the beams was determined by measuring deflections of both slabs and cantilever at a series of points lying along a line perpendicular to the beams. The deflections were then plotted and a smooth curve drawn which showed at a glance whether or not horizontality existed. It was often

TABLE IV. TWO-WAY TILE AND CONCRETE FLOOR. SUMMARY OF PRINCIPAL STRESSES AND DEFLECTIONS

Deflections at Center

Design load, 150 lb. per sq.ft.	0.167 in., or $\frac{1}{1920}$ of span
St. Louis building code, 380 lb. per sq.ft.	0.860 in., or $\frac{1}{375}$ of span

Concrete Stresses

Location			Gage point	Design Load 150 lb. per sq.ft. L.L.	D.L.	Total	St. Louis Code 380 lb. per sq.ft. L.L.	D.L.	Total
Top of slab at center	Long span		402	100	100	200	675	100	775
	Short span		401	100	100	200	800	100	900
Bottom of slab at flange of supporting beam	Long span		304	325	150	475	1250	150	1400
	Short span	Fixed end	301	400	200	600	1525	200	1725
		Free end	309	150	75	225	425	75	500
Bottom of slab on rib just outside of beam flange	Long span		308	175	75	250	925	75	1000
	Short span	Fixed end	303	400	200	600	1575	200	1775
		Free end	311	175	100	275	700	100	800

Steel Stresses

Location			Gage point	Design Load 150 lb. per sq.ft. L.L.	D.L.	Total	St. Louis Code 380 lb. per sq.ft. L.L.	D.L.	Total
Bottom of slab at center	Long span		122	3500	2000	5,500	19,500	2000	21,500
	Short span		113	7500	3500	11,000	26,500	3500	30,000
Top of slab at support	Short span	Fixed end	201	6500	3500	10,000	28,500	3500	32,000
		Free end	219	7500	4000	11,500	85,000	4000	12,500
Bottom flange of I beam	Short span		101 & 103	7000	3500	10,500	17,500	3500	21,000
	Long span	Spandrel beam	128	3500	2000	5,500	9,500	7000	11,500
		Interior beam	124 & 126	7500	4000	11,500	22,000	4000	26,000

Note.—Stresses due to dead load are obtained by projecting the stress curve to the zero load.

found necessary to shift the load on the cantilevers several times before the correct amount and position were reached.

Two test cylinders, 8x16 in., were taken from the mixer at the time the slab was poured and after being cured under the same conditions as the panel itself. The ultimate strength and the modulus of elasticity of these were widely different, but in deriving the concrete stresses the average modulus was used, being taken at 3,250,000.

Concrete stresses were read at the points shown in Fig. 15 and the same figure shows the location of gage points at which steel stresses were read.

A summary of the stresses and deflections at the critical points of the slab is given in Table IV.

Measurement of Actual Stresses in Reinforced-Concrete Structure: Franks Building, Chicago*

By W. K. Hatt†

This paper is mainly an account of the general features of a test of a reinforced-concrete floor of flat-slab construction. The full report of the test with all pertinent data was made to the Leonard Construction Co., Chicago, which has permitted the writer to use the report as a basis for this paper.

Nature of Tests—In brief, the floor was loaded with pig iron in increments, and the accompanying deformations were measured in the steel and in the concrete at all critical points, with a view to fixing a safe limit of loading and to understanding the mechanical action of the structure.

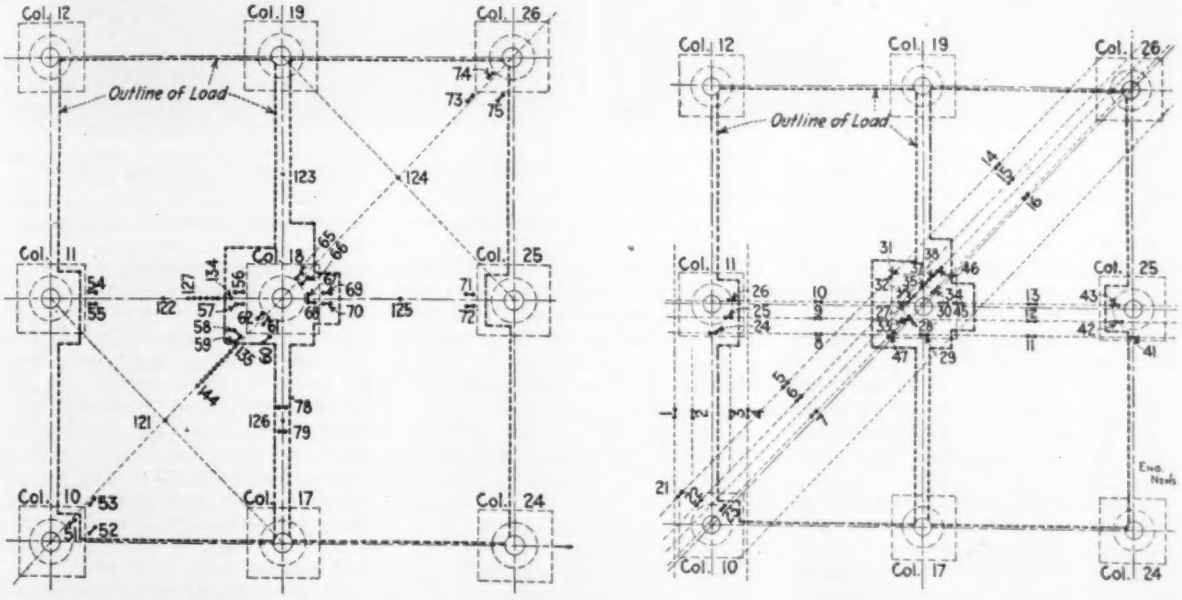
The Structure Tested—The building tested is the Franks Bldg., Chicago, Ill., a 10-story-and-basement warehouse used by the printing and paper trades and the type of construction used was the "Cantilever Flat Slab" system. The design load on the floors was taken at 250 lb. per sq.ft. The panel dimensions were 19 ft. 4 in. by 20 ft. 3 in.

The four panels under observation were in the interior of the building, and on the tenth floor, where the columns were of minimum size. As the effective clear span and the eccentricity of column loading were the greatest, the location was such as to insure the most severe test possible.

The diagonal reinforcement was eighteen ½-in. round bars, 40 ft. long, spaced 5⅝ in. on centers. The cross bands were composed of sixteen ½-in. round bars 44½ ft. long, spaced 6⅛ in. on centers. The slab thickness was 9¼ in., increased to 13¼ in. near the columns. The concrete mix was 1:2:4 in the floors and 1:1:2 in the columns.

Methods of Observation—The observations were made by experienced observers: Prof. H. H. Scofield, of Purdue University, and Prof. W. A. Slater and W. E. Ensign, of the University of Illinois Engineering Experiment Station, with the assistance of Prof. L. W. Weeks, of Purdue University.

The deformations were determined by the use of extensometers of the type devised by Prof. H. C. Berry, of the University of Pennsylvania, a former pupil of the writer at Purdue University. On the steel a gage length of 10 in. was used, which, with the multiplying lever in the instrument, gave direct readings of unit deformations of 0.00002-in. per in., corresponding to stresses of 600 lb. per sq.in. in the steel, and it was possible to estimate clearly fractions of this amount. For the concrete readings the gage-length was 6 in., and the direct reading of unit deformations was 0.000033 in. per in., corresponding to a stress of 133 lb. per



Gage-Points for Deflections and for Measurements of Compression in Concrete

Gage-Points for Measurements of Tension in the Slab Steel

Fig. 1. Locations of Gage Lengths for Steel and Concrete Stresses, and Points at which Deflections were Measured

No definite conclusions as to the distribution of stress among the two sets of ribs can be reached from the data obtained in this one test, although the stresses obtained indicate that about 65% of the load was carried across the short span of the panel, instead of the 55% assumed.

Typhoid Fever at Waukegan, Ill., said to be due to drinking "raw, unfiltered water taken from Lake Michigan at points close to the sewage outfalls," ran up to 160 deaths per 100,000 in 1910, and 120 in 1911, according to statements made by Dr. W. A. Evans, late Health Commissioner of Chicago, in the Chicago "Tribune," of April 1. The reported cases having recently increased to five per day, it was decided to install a hypochlorite plant. Dr. Evans states that "four hundred cities are now chlorinating their water."

*A paper read before The Indiana Engineering Society, January, 1912. This article has no connection with those printed on the previous pages as portions of the committee report to the National Association of Cement Users, but is given here on account of the similarity in its matter.—Ed. Eng. News.

†Professor of Civil Engineering, Purdue University, Lafayette, Ind.

sq.in., and it was possible to estimate fractions of this amount with accuracy.

Errors in operating the instrument were reduced to a minimum by taking every reading at least five times, and by calibrating on a standard bar at frequent intervals. Four standard bars were used throughout the test, all of these being embedded in the concrete and subject to the same temperature changes as the rods in the test floor, but free from any stress due to applied load. By reading on these bars between sets of five or six test readings, the observations on the materials under test were freed from errors caused by temperature differences and from systematic errors.

Deflections were measured to 0.0001 in. by use of the deflectometer described in a previous test for actual stresses.

Tensile deformations were measured throughout the test over 42 gage-lengths on the steel reinforcing rods. Compressive deformations in the concrete were measured over 26 gage-lengths. Deflections were observed at 24 points. Also, 27 other readings of deformations were taken throughout the test, to study such phenomena as the arch and slab action, the distribution of stress, and the eccentric loading on the columns at the edges of the loaded area. The locations of the various gage-lengths are shown by the two diagrams Fig. 1; see, also, the view Fig. 2.

The observations were arranged in groups, each designed to cover adequately some particular feature, and symmetrically located observations were obtained as a check in every case where possible, in order to cover variations in the quality of the concrete at different points.

It should be remarked that the results from the use of the Berry extensometer are reliable only after the observer has had considerable preliminary practice with this instrument. The holes in the steel bars must be carefully reamed, the instrument must be protected from the heat of the hands, and the contact points must be seated under uniform pressure. Observance of these requirements, multiplied observations, and frequent reference to the standard calibration bar, are the conditions of success.

FIG. 2. VIEW OF SLAB FROM BELOW, SHOWING COLUMN CAPITAL AND SEVERAL OF THE GAGE-POINTS

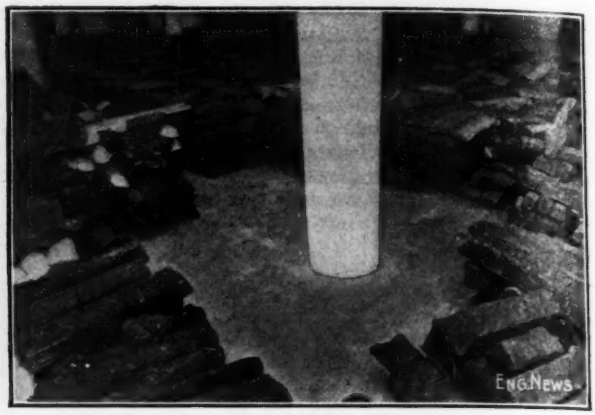


FIG. 3. VIEW OF SLAB WITH PIG-IRON LOADING, SHOWING SPACE LEFT FOR MAKING READINGS

(At the time these pictures were taken, the four panels shown carried 20% overload.)

The conditions were exceptionally favorable to a satisfactory test. The building was practically completed at the time of test. The temperature varied but little, being about 74° at the start of the test, dropping gradually and uniformly to 70°, and rising again at the end to 74°. The slab was poured on June 23, 1911, and was 64 days old when the maximum load of 624 lb. per sq.ft. of panel area was placed upon it.

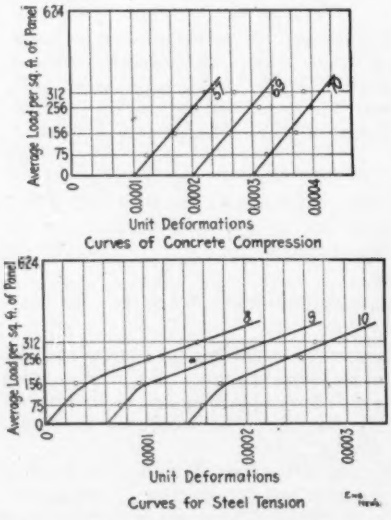


FIG. 4. TYPICAL LOAD-STRAIN CURVES, FROM TESTS IN FRANKS BUILDING

LOADING—The amount of loading was determined by the weight of the pig iron as recorded on the weigh bills delivered by the teamsters, and was checked by weighing a number of piles of pig iron from the test load on a platform scales.

The pig iron was piled on the floor in separate piers, each placed within a 2-ft. square, so that no arch action existed in the load itself to relieve the panel from moment. It was necessary to leave several of these squares vacant about columns and to leave an aisle between the columns to allow space for observations (see view Fig. 3). The pig iron belonging on these vacant squares was distributed over the remaining squares of the same panel. It will be apparent that under this procedure the real load intensity, as affecting bending stresses and deflections, is the intensity of loading over the loaded area (about 90% of the panel area), rather than the nominal or average load over the entire panel area.

All gage-lengths were measured and checked throughout before loading was started. When the loading reached certain amounts, distributed evenly over four panels, it was discontinued and allowed to stand for six hours before the observations were made and the loading resumed.

The increments of load at which measurements were made were as follows: 75, 150, 256 (the design load), 312 (intensity 359), and 624 (intensity 717) lb. per sq.ft., the latter load being applied only to two panels adjoining diagonally. Readings were also taken with 256 on two diagonal panels and 312 on the other two panels, and with 468 on two diagonal panels and 156 on the others, but without waiting for the six-hour interval to elapse before taking readings.

The total number of complete observations over single gage-lengths was over 2000, and the total individual readings over 10,000. The test occupied one week's time.

STRESSES—The stresses were determined from the observed deformations by using a modulus of elasticity of 30,000,000 lb.

TABLE OF ACTUAL STRESSES OBSERVED IN TEST OF FRANKS BUILDING

All stresses are the final values for total dead and live-load, and are given in pounds per square inch.

Average of Observations Nos.	Description	Live-load, lb. per sq.ft. 256	312	624
STRESSES IN SLAB RODS				
5, 6, 7, 14, 15, 16	Center of span, diagonal band	1071	1920	6950
8, 9, 10, 11, 12, 13	Center of span, cross band	4539	6140	10095
31, 32, 33, 34, 35, 37	Over capital at center column, diagonal band	3440	4350	9280
27, 28, 29, 30	Over capital at center column, cross band	4575	4840	8140
21, 22, 23	Over capital at corner column, diagonal band	1920	2280	7540
24, 25, 26, 41, 42, 43	Over capital at side column, cross band	2690	3138	5315
COMPRESSIVE STRESSES IN CONCRETE				
56, 57, 59, 60, 68, 69, 70	On slab at center column	560	650	1206
61, 62, 65, 66	On drop at center column	677	778	1685
51, 74	On drop at corner column	318	370	1515
52, 53, 73	On slab at corner column	329	378	650
54, 55, 71, 72	On slab at side columns	189	217	420
MAXIMUM BENDING STRESSES IN COLUMNS				
104	Compression in concrete, corner column	680	840	1660
109	Compression in concrete, side column	416	512	1000
84	Tension in steel, corner column	4980	6000	11620
99	Tension in steel, side column	2220	2640	5880
DEFLECTIONS IN INCHES				
121, 124	Center of panel—at 6 hours	0.123	0.156	0.475
	Center of panel—at 24 hours			0.500
	After standing unloaded 6 hours	0.142		
	After standing unloaded 2½ days	0.091		

Note: The loadings of 256 and 312 pounds per square foot were on four adjacent panels. The loading of 624 lb. per square foot was on two panels adjoining diagonally.

per sq.in. for the steel, and 4,000,000 lb. per sq.in. for the concrete. The latter value was determined from tests of three concrete prisms poured from the concrete in the test slab and tested at Purdue University at an age of 77 days.

Load-deformation curves were plotted for each observation point, the known nature of the curve under flexure being used as a basis; typical curves are shown in Fig. 4 herewith. The dead-load stress has been taken from these curves as equal to the stress caused by an equal live load.

The above table gives a summary of the corrected values of the total dead- and live-load stresses found from the various groups of observations. The detailed summary of individual stresses at the various observation points is omitted in this paper.

Comments on the Results

The writer is not prepared at the present time to state the significance of the results obtained with respect to the mechanics of this form of construction. Such statements would be somewhat speculative, and should be separated from the report of test, which is one of measured facts.

The Slab Design—As compared with the design requirements of the Chicago Building Code, it is interesting to note that at design load the highest average stress in the steel is 5078 lb. per sq.in. (average of observations 11, 12 and 13), while the highest average compressive stress in the concrete is 677 lb. per sq.in. On the basis of safe working stress in the steel of 16,000 lb. per sq.in., and in the concrete of 35% of the ultimate strength (which averaged over 3250 by tests of prisms) or 1100 lb. per sq.in., it appears that the steel is stressed to 31% of its safe load, while the concrete is stressed to 62% of its safe load. It appears, therefore, that the design is overbalanced with an excess of steel. At the highest applied load of 717 lb. per sq.ft. the ratio of the steel and concrete stresses remains practically unchanged.

Column Bending—The eccentric action of the test load was most marked on the corner columns of the loaded area, and was sufficient to produce a tension in the steel of 4980 lb. per sq.in.

With respect to the strength of the structure, it may be said that a nominal load of 624 lb. per sq.ft. of panel, which actually was 717 lb. per sq.ft. of loaded surface, was applied without producing any permanent damage to the building. At this load the highest observed average total dead- and live-load stresses were less than 12,000 lb. per sq.in. in the steel and less than 1700 lb. per sq.in. on the concrete.

A Method of Analyzing Radially Reinforced Flat Slabs

By S. E. Slocum*

In view of the recent discussion of the radial system of reinforced-concrete construction, the following simple presentation of the chief features in the design and analysis of stress for this method of reinforcement may be of general interest.

Diameter of Top—It is obvious that in the case of a continuous floor slab supported by several columns, the slab will be concave downward over the columns and concave upward in the center of each panel. Between these two extremities there must be a boundary at which there is no curvature, i.e., a line of inflection. In a continuous beam of length l, bearing a uniform load, the two points of inflection occur at a distance of 0.212 l from each support. For a continuous slab, therefore, the line of inflection (for square panels) may be assumed to be approximately a circle of radius between $\frac{1}{5}\ l$ and $\frac{1}{4}\ l$, where l denotes the span, or distance center to center of columns. In practice we may therefore assume the diameter D of the column top (see Fig. 1) as:

$$D = \tfrac{7}{16}\ l,$$

which is approximately the mean of the above values.

There is another condition, however, which also affects the diameter of the top, namely the distribution of slab reinforcement. If the column top is too small there will be portions of the slab which contain no reinforcement, as shown by the triangular areas a, b, c, d in Fig. 2. The arrangement shown in Fig. 3 has no such gaps; it requires that

$$D^2 + D^2 = (l - D)^2,$$

or

$$D = \frac{l}{1 + \sqrt{2}} = 0.414\, l$$

which determines the minimum diameter of column top. If then D is assumed as $\frac{7}{16}\ l$ ($= 0.4375\ l$), a slight overlap of the reinforcing rods is assured.

Efficiency of the Spider Hoops—The efficiency of tensile reinforcement in the form of hoops as compared with direct reinforcement may be obtained approximately as follows:

For the case of column tops here considered, reinforced against tensile stress by hoops, take a diametral section of the top and consider half of one hoop and the portion of the material reinforced by this segment, as shown in Fig. 4. Let w denote the radial stress, or pressure on the inside of the hoop, per unit of length, expressed, say, in pounds per linear inch of hoop. Also let r denote the radius of the hoop, A its cross-sectional area, and p the unit-stress in the metal. Then the radial force acting on any portion of the hoop of length ds is $w ds$, and the component of this force perpendicular to the plane of the section is $w ds \sin \alpha$. Or, since $ds \sin \alpha = dx$, that is, the projection of ds on the diameter, this component becomes $w dx$. Therefore, equating the tension in the hoop to the sum of the components of the radial stress perpendicular to the plane of the section, we have

$$2\ p\ A = \Sigma w\, dx = w \Sigma dx = w\, 2\, r$$

whence

$$A = \frac{wr}{p}$$

Now let A' denote the cross-sectional area of an equivalent amount of radial reinforcement. Then since the length of the arc considered is πr and the radial stress is of amount w per unit of length, the total amount of radial reinforcement required would be given by the equation

$$p\ A' = \pi r w,$$

whence

$$A' = \frac{\pi r w}{p}$$

*Professor of Applied Mechanics, University of Cincinnati, Cincinnati, Ohio.

Comparing these expressions for A and A', it is found that

$$A' = \pi A = 3.14\ A.$$

Consequently the theoretical efficiency of tensile reinforcement in the form of hoops is 3.14 times as great as the same cross-sectional area of direct, or radial, reinforcement. The amount of metal in a hoop of radius r, however, is $2\pi rA$, whereas that in the radial reinforcement is $A'2r$, and since $A' = \pi A$, these volumes are equal. Consequently there is no saving in material effected by making the reinforcement in the form of hoops. But when there is such a complex system of reinforcement as shown in Fig. 1, some of the metal may be used to better advantage in the form of hoops, as this lessens somewhat the congestion of metal at the columns.

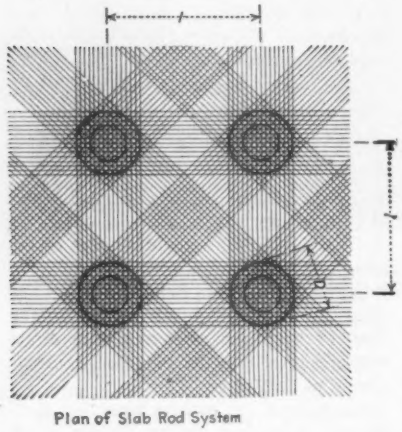


FIG. 1. REINFORCEMENT OF A SQUARE SLAB ON THE RADIAL SYSTEM

MAXIMUM MOMENT—For a continuous beam of span l, and carrying a total uniform load of amount W, the moment at the supports is $\frac{Wl}{12}$, whereas the moment at midspan is one-half this amount, or $\frac{Wl}{24}$. Assuming that each of the four sets of slab rods carries one-fourth the total load, the bending moment from which to determine the thickness of the slab and amount of reinforcement in the head becomes

$$\frac{\frac{W}{4}l}{12} \text{ or } M = \frac{Wl}{48}$$

where W denotes the total load on the panel, and l is the distance center to center of columns. The formula determined by experiment and used in practice is $M = \frac{Wl}{50}$. For a top diameter $D = \frac{7}{16}\ l$, the moment per foot of width, say M_1, is therefore $M_1 = \frac{Wl}{50} \div \frac{7}{16}\ l$ or

$$M_1 = \frac{Wl}{50} \div \frac{7}{16}\ l = \frac{W}{22} \text{ ft.-lb.}$$

THICKNESS OF SLAB—Let the necessary terms be denoted by:

p_s = Unit working tensile stress in reinforcement,

p_c = Unit working compressive stress in concrete,

$n = \frac{E_s}{E_c}$ = ratio of elastic moduli,

M_1 = Bending moment in foot-pounds per foot of width.

Then the thickness of slab h from outer fiber in compression to center of reinforcement is given by the formula*

$$h = \frac{p_s + n p_c}{p_c} \sqrt{\frac{6 M_1}{n (3 p_s + 2 n p_c)}}$$

For working values of $p_s = 16{,}000$ lb. per sq.in., $p_c = 600$ lb. per sq.in., and $n = 15$, this becomes

$$h = 0.1026 \sqrt{M_1}$$

Since $M_1 = \frac{W}{22}$ as explained above, this may also be written

$$h = 0.02187 \sqrt{W}$$

where h is expressed in inches and W denotes the total load on the panel in pounds.

The total thickness of slab is then found by adding to this value of h the amount needed for the reinforcing rods plus a small amount for bond below the bottom rods.

The amount of reinforcement for the unit stresses assumed above is then found from the relation†

$$A = 0.081\ h$$

where h is expressed in inches and A in square inches per foot of width.

AREA OF SLAB RODS—As stated above, the moment at the center of the slab is half as great as at the supports. The effect of this on the required dimensions of the slab and reinforcement would be to divide both h and A by $\sqrt{2}$. But since the slab is necessarily of the same thickness throughout and hence is thicker at the center than necessary, the cross-sectional area of the reinforcement in the slab may be lessened so as to make the moment of the stress in the reinforcement equal to the moment required for the thinner slab. If then p denote the unit-stress in the metal, assumed to be the same in both cases, and A' denote the cross-sectional area of metal actually required, the condition that the moment shall be constant is

$$k p A' h = k p \frac{A}{\sqrt{2}} \cdot \frac{h}{\sqrt{2}}$$

whence

$$A' = \frac{A}{2}$$

Consequently the design is made up by placing half the required cross-sectional area, obtained from the formula $A = 0.081\ h$, in the slab rods, and the other half in the hoops and spider in the column top.

APPLICATION OF FORMULAS—To illustrate the use of these formulas, consider a floor system with panels 20 ft. square and carrying a live load of 200 lb. per sq.ft. By a preliminary calculation it is found that the floor slab will be about 9 in. thick, giving a dead load of 115 lb. per sq.ft. The total live and dead load is therefore 315 lb. per sq.ft. Consequently $W = 20^2 \times 315 = 126{,}000$ lb., and

$$h = 0.02187 \sqrt{126{,}000} = 7.76 \text{ in.}$$

The total area of reinforcement in the head for each radial system is then

$A = 0.081\ h = 0.628$ sq.in. per foot.

Since the diameter of the top is assumed as $D = \frac{7}{16}\ l = 8.75$ ft., the total area required for one radial system is $8.75\ A = 5.5$ sq.in.

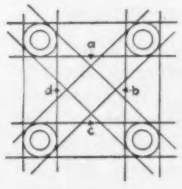


FIG. 2
UNREINFORCED SPACES LEFT

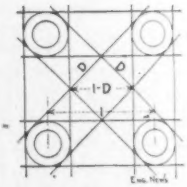


FIG. 3
BANDS COVER ENTIRE AREA

The required area of slab rods in one system is then $\frac{5.5}{2} = 2.75$ sq.in., equivalent to 18 rods $\frac{7}{16}$ in. in diameter, spaced 5 in. apart.

Since the four sets of rods overlap where they cross the column top, and h denotes the distance from the extreme fiber in compression to the center of the nearest rod, the total thickness of slab becomes $h + 3\frac{1}{2}\ d + \frac{1}{4}$ in. $= 10$ in.

Since the hoops around the column head are assumed to be π times as effective as the same cross-sectional area of radial reinforcement, the total area of

*Slocum and Hancock, "Strength of Materials," Revised Edition, p. 75 (Ginn & Co., Boston).

†Ibid, p. 75.

TABLE FOR FLAT-SLAB SYSTEM

$h = 0.02187\sqrt{W}$ $\quad \log 0.02187 = 8.339836-10$
$A = 0.081\ h.$ $\quad$ Column top $D = \frac{1}{4}\ l$

	Live-load 80 lb. per sq.ft.	100 lb. per sq.ft.	125 lb. per sq.ft.	150 lb. per sq.ft.	200 lb. per sq.ft.	250 lb. per sq.ft.	300 lb. per sq.ft.
Panel 14x14 ft. Col. top 6 ft. 2 in.	5½-in. slab 65 lb. D.L. 13-7/16-in. r.	5½-in. slab 70 lb. D.L. 14-7/16-in. r.	5½-in. slab 70 lb. D.L. 15-7/16-in. r.	6½-in. slab 80 lb. D.L. 11-¾-in. r.	6½-in. slab 85 lb. D.L. 12-¾-in. r.	7½-in. slab 90 lb. D.L. 13-¾-in. r.	7½-in. slab 95 lb. D.L. 14-¾-in. r.
Panel 16x16 ft. Col. top 7 ft.	6½-in. slab 80 lb. D.L. 12-¾-in. r.	6½-in. slab 80 lb. D.L. 13-¾-in. r.	6½-in. slab 85 lb. D.L. 14-¾-in. r.	7-in. slab 90 lb. D.L. 15-¾-in. r.	7½-in. slab 95 lb. D.L. 16-¾-in. r.	8-in. slab 100 lb. D.L. 17-¾-in. r.	8½-in. slab 110 lb. D.L. 14-7/16-in. r.
Panel 18x18 ft. Col. top 8 ft.	6½-in. slab 85 lb. D.L. 15-¾-in. r.	7-in. slab 90 lb. D.L. 16-¾-in. r.	7½-in. slab 95 lb. D.L. 18-¾-in. r.	8-in. slab 100 lb. D.L. 14-7/16-in. r	8½-in. slab 110 lb. D.L. 15-7/16-in. r.	9½-in. slab 120 lb. D.L. 17-7/16-in. r.	10½-in. slab 130 lb. D.L. 14-½-in. r.
Panel 20x20 ft. Col. top 9 ft. 8 in.	7½-in. slab 95 lb. D.L. 14-7/16-in. r.	8-in. slab 100 lb. D.L. 15-7/16-in. r.	8½-in. slab 105 lb. D.L. 16-7/16-in. r.	9-in. slab 115 lb. D.L. 17-7/16-in. r.	9½-in. slab 120 lb. D.L. 18-7/16-in. r.	10½-in. slab 130 lb. D.L. 16-½ -in.r.	11½-in. slab 140 lb. D.L. 17-½-in. r.

Note—In this table the thickness of concrete below bottom of rods has been assumed as about ½ in., which has been proved by experiment to be sufficient for fireproofing purposes. Some fireproofing specifications require more, however, in which case it will be necessary to increase the thickness of slab given in the table to the required amount.

the hoops, neglecting the spider, is $\frac{2.75}{3.14} = 0.88$ sq.in. If two hoops are used, the diameter of each hoop rod may therefore be assumed as ¼ in., giving a total cross-sectional area of 0.88 sq.in.

It should be noted, however, that the effectiveness of hoop reinforcement depends on the hoop being placed where it can carry the tensile stress in the column top. Since the outermost hoop of the top is placed as nearly as possible on the line of inflection, there is practically no stress in the slab at this point except shear, and hence the cross-sectional area of the outer hoop should be neglected in dimensioning the top hoops.

DIMENSION TABLE—By the use of the above formulas as just explained, the accompanying table has been calculated, giving the required thickness of slab and also the size and number of slab rods for various spans and loads.

DIMENSIONS OF SPIDER—The size and number of rods in the spider are determined from the condition that the total area shall be sufficient to carry the shear, as will now be shown.

It is customary to place a fillet at the top of each column as shown in Fig. 1, the depth of the fillet being not less than the thickness of the slab, and its diameter about twice the diameter of the column. The area of concrete in shear at the face of the column is then $\pi d\ (2t)$, where d denotes the diameter of the column and t the thickness of the slab, and at the outside of the fillet is $\pi(2d)t$, which is of the same amount. Consequently a fillet of these dimensions doubles the area of concrete in shear. The chief purpose of the fillet, however, is to avoid the weakening effect of an angle and thus enable the slab to develop its full strength at its junction with the column.

Since there are more slab rods to carry the shear at the outside of the fillet than at the face of the column, the latter section is weakest in shear. To illustrate the method of dimensioning for shear, consider the same numerical problem as above, namely, a panel 20x20 ft. with a total live and dead load of 320 lb. per sq.ft. The total load on each column, or the shear, is then $320 \times 400 = 128{,}000$ lb. Assuming that the columns supporting the floor are 1 ft. in diameter, and taking a cylindrical section at the face of the column, the total area of concrete in shear, including the fillet, will be $\pi \times 12 \times 2 \times 9.5 = 716$ sq.in. For a working stress in shear of 30 lb. per sq.ft., the shearing strength of the concrete alone is therefore $716 \times 30 = 21{,}480$ lb.

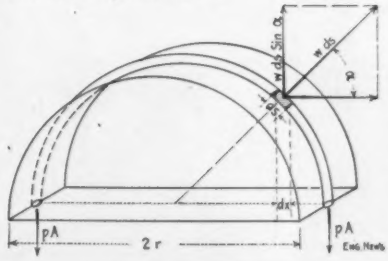


FIG. 4. A HALF-CYLINDER REINFORCED BY A HOOP AGAINST RADIAL PRESSURE

The amount of metal in the slab rods was determined previously as 0.628 sq.in. per foot. Since the column is 1 ft. in diameter, and since each set of rods is in double shear and there are four sets of rods, the total area of metal in shear at the surface of the column is $8 \times 0.628 = 5$ sq.in. Assuming the working stress in shear of the metal as 10,000 lb. per sq.in., the shearing strength developed by the slab rods alone is $5 \times 10{,}000 = 50{,}000$ lb. Since the total load is 128,000 lb., there still remains to be taken care of $128{,}000 - (21{,}480 + 50{,}000) = 56{,}520$ lb. of shear.

To design the spider to carry this shear, assume that it is made up of 8 rods, as shown in Fig. 1. Then the amount of shear on each rod will be $\frac{56{,}520}{8} = 7065$ lb., and hence the required area of each rod will be $\frac{7065}{10{,}000} = 0.7$ sq.in., giving a rod slightly less than 1 in. in diameter.

If the fillet under the head is neglected in computing the shearing strength of the concrete, a spider made up of eight 1-in. rods will still give sufficient area to develop the required shearing strength.

Cost of Electric Traction on the Pennsylvania and Long Island railroads in 1911 was given by George Gibbs, Chief Engineer of electric traction, Pennsylvania Tunnel and Terminal Co., New York City, at a meeting of the New York Railroad Club, on Friday, Mar. 15.

His figures showed 152 miles of electrified main track, belonging to the Long Island road, over which 8,600,000 car miles were run, at an operating cost, including Interstate Commerce Commission items and depreciation, of 24.2c. per car mile. Power cost 3.12c. per car mile, with energy at 1.02c. per kw.-hr. at the third-rail shoes. There were 269 mechanical and electrical failures, with 8000 train miles, 28,000 car miles, and 29 hours average time interval between detentions. In spite of a doubling of mileage, the number of failures had decreased and the train mileage between failures had nearly tripled. Maintenance costs had dropped 10%, but car-mile costs for power had increased 13% because of larger cars. The cost of power delivered at the shoes had decreased 22%.

Mr. Gibbs' figures for the New York terminal service of the Pennsylvania R.R. showed nine miles of main line, with about 6½ miles of level track and 2½ miles of heavy grade, in addition to an underground run of four miles from the station to the yards on Long Island. Practically all traffic was locomotive hauled, although there was a very small motor-car service between Harrison, N. J., and New York; there was much switching and transfer. The extra dry condition of the tunnel permitted a higher coefficient of adhesion than designed, so that the locomotives were able to start a 650-ton train readily and occasionally an 800-ton. Station service limitations kept the average locomotive performance to 26,000 miles per year (with a maximum of 56,000). Of a total of 909,000 locomotive miles, 72% was in road service and 28% in switching service.

Total operating costs per car mile of the Pennsylvania electric locomotives were compared with steam locomotives (1) on the New Jersey division and (2) on all divisions, as follows: electric, 5.91c.; N. J. steam, 8.83c.; all steam, 11.9c. The cost of lubrication was the same for all at 0.25c., while engine-house expense was 0.58c. per car mile for electrics, compared with 2.58c. for both New Jersey and all-division steam (steam locomotive figures taken from pooled figures, as the Pennsylvania R.R. does not segregate locomotive figures according to class of service). The figures for repairs were probably higher than some expected, but were considered low on account of the exacting service, and the presence of expenses in the first year of operations which would not arise subsequently. Thus the heaviest items were for brake shoes, tire turning and structural changes; for instance, some of the jack-shaft bearings had unsuitable babbitt, and many flat wheels were due to the inharmonious proportions of original brake rigging. In the past year there have been only 16 locomotive failures, detaining 26 trains an average of 6.8 minutes. There were about 35,000 train miles per detention, and 56,000 train miles to each locomotive failure.

The Largest Hydraulic Turbines in the World

By Arnold Pfau*

The designers of the largest hydraulic turbines built describe the principal features of the hydraulic equipment of the station where they are installed—runners, casings, friction brakes, large butterfly valves, governors, pressure regulators, breaking plates, oil-pressure system, and exciter units—and state the reasons for special features.

*Consulting Engineer, The Allis-Chalmers Co., Milwaukee, Wis.

In connection with the White River hydro-electric development of the Pacific Coast Power Co., of Seattle (described in ENGINEERING NEWS, Apr. 11, 1912), the most powerful hydraulic turbines yet constructed were designed. As any general description of this development can hardly be expected to show the turbine design adequately, their principal engineering features will here be sketched.

MAIN TURBINES—Each turbine was designed to develop 18,000 b.hp. at 360 r.p.m. under 440 ft. effective head. Each is capable of developing 20,400 b.hp. with a maximum head of 480 ft., and at the same speed. All parts of the turbine are designed to withstand the maximum pressure of 480-ft. head, and the runaway speed of the rotors under this head brings no undue stresses. These turbines now carry 20,800 hp. in service under the lower normal head and this gives them the greatest capacity of any in the world.†

From the accompanying figures it is evident that the turbines are of an inward-flow reaction type, commonly called the "high-head Francis." At the wish of the purchaser, a spiral-case double-discharge arrangement was adopted. The operating water enters the spiral casing from below, and passes around this and out through the speed ring; immediately upon entering the runners it is divided along two paths with separate quarter turns and steel-plate draft tubes.

†The nearest approach seems to be with the 18,000-hp., 525-ft.-head turbines of the Great Western Power Co., at Oroville, Calif. However, these were tested at 14,000 hp. under 410 ft. head. See Eng. News, Feb. 24, 1910.—Ed.

To facilitate the erection and to enable complete assembling at the shop, the turbine was designed entirely self-contained. All the main elements are mounted upon a base plate which, once leveled on the foundation and properly grouted in place, forms a reliable base for the whole machine. The spiral casing is of cast steel, made to withstand a test pressure of 385 lb. per sq.in.; it was annealed to increase its resistance against the positive and negative pressure variations, which may occur in exceptional cases of severe load changes. This casing is split in a horizontal plane through the center line of the shaft. Fig. 3 shows that opposite the inlet-pipe connection is an outlet branch for connecting the relief-valve pressure regulators, to be noted later. A number of interesting problems had to be met in order to secure economy in manufacture, together with the proper amount of material, for in work of this nature, the designer can depend entirely on neither calculation nor "practical feeling."

To reduce the stress in the casting, which would result if the inner ring of the casting were entirely open, a skeleton speed ring of annealed cast steel is bolted over this inner opening, and its substantial webs form a solid cross-connection without obstructing the radial flow of water. The two inner flanges of the same speed ring carry the speed-gate covers, which in turn are bolted to the quarter turn discharge pipe and are also bored out to receive the several bronze bushings, which form the bearings for the pivoted guide vanes (see Fig. 4). Inner radial faces of the speed-gate covers are lined with removable facing rings to take the grinding wear expected from the presence of glacial silt in the White River.

High velocities are allowable in spiral cases under high head, but all obstructions to free water passage have to be avoided and all friction contacts have to be kept outside of the casing for ready inspection and easy lubrication; in this case, therefore, the so called "outside" gate rigging was adopted. The guide vanes (speed gates) and pivots are forged in one piece, the pivots projecting on either side through bronze-bushed bearings and large packing boxes to the outside of the speed-gate covers. The guide-vane pivots, on the side opposite the generator, carry levers which are connected to a shifting ring by individual links and steel pins. This ring moves in bronze ways bolted to the speed-ring flange. The shifting ring is a single an-

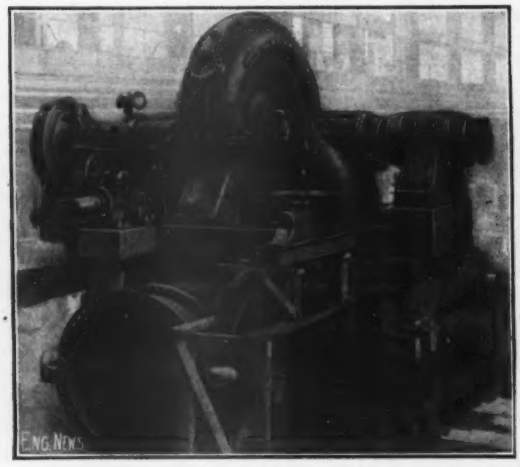


FIG. 1. SHOWING PENSTOCK CONNECTION

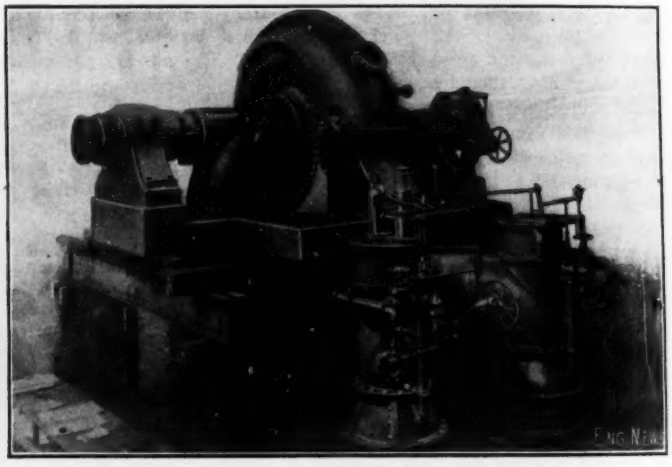


FIG. 2. SHOWING PRESSURE REGULATORS

FIGS. 1 AND 2. TWO SHOP VIEWS OF AN 18,000-HP. FRANCIS TURBINE
(Built for the White River Plant of the Pacific Coast Power Co., by the Allis-Chalmers Co.)

nealed-steel casting with two lugs for the pins of the governor connecting rods, as may be seen from Figs. 1, 2 and 3. Each rod is operated by a bell crank and these are rigidly inter-connected by a horizontal rod underneath the shaft and directly connected to the main control lever and piston, as shown in Fig. 3. The maximum force produced by the governor oil pressure upon the regulating piston is 50,000 lb., and all connections, including the shifting ring, are made strong enough to withstand this pressure.

ring and guide-vane levers have been made to break at predetermined overload. The guide vanes tend to close to a no-load normal-speed opening, so that two broken links will not materially effect the runner speed. The levers are easily removed, and the two links may be exchanged without shutting down.

The runner is a solid steel casting, machined all over, carefully balanced and the water passages made to template. The runner is bolted to a flange of the shaft and machined cover rings form a smooth

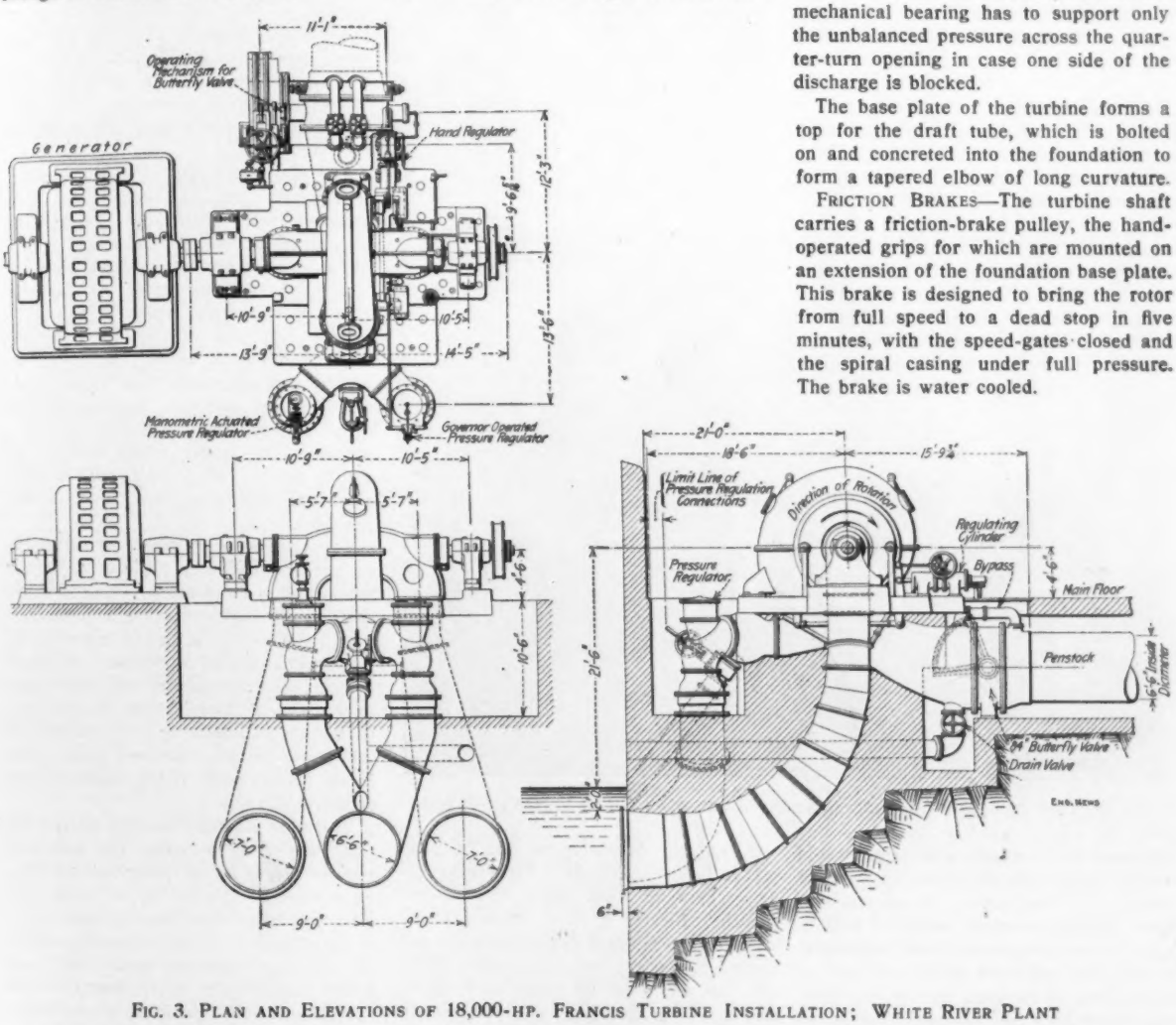


FIG. 3. PLAN AND ELEVATIONS OF 18,000-HP. FRANCIS TURBINE INSTALLATION; WHITE RIVER PLANT

If the guide-vane pivots were directly connected to the shifting ring, and any foreign matter should locate between two guide vanes to prevent closing them, then the governor would concentrate full force upon these two guide vanes and their pivots and levers which would be damaged unless of dimensions that would seriously interfere with the proper design of the guide-vane body and increase the friction of the whole gate rigging. Therefore, the stems and levers are proportioned to resist only the forces of normal operation; the connecting links between shifting guide for the discharge from the runner passages to the quarter turns. The shaft is an openhearth-steel forging and rests in two ball-and-socket bearings. It has a diameter of 16 in. in the bearing at the generator end, and this is increased to 32½ in. at the center flange. The outer bearing serves as a thrust and steady bearing, with three collars forged with the shaft. Both bearings have babbitt-lined shells and oiling rings dipping into large reservoirs in the pedestals.

The shaft packing boxes are of interest, for with a diameter of 16½ in. at the quarter turns, the use of hemp is prohibited. A water-seal box has been used, operating automatically either at over pressure in the quarter turn or under vacuum. Disks on the shaft revolve in chambers connected to either circulating-water lines or drain pipes from the draft tubes.

Balancing in normal operation is relatively easily accomplished here with double-discharge runners. The speed-gate covers also form pockets between the covers and the runner walls, so that the mechanical bearing has to support only the unbalanced pressure across the quarter-turn opening in case one side of the discharge is blocked.

The base plate of the turbine forms a top for the draft tube, which is bolted on and concreted into the foundation to form a tapered elbow of long curvature.

FRICTION BRAKES—The turbine shaft carries a friction-brake pulley, the hand-operated grips for which are mounted on an extension of the foundation base plate. This brake is designed to bring the rotor from full speed to a dead stop in five minutes, with the speed-gates closed and the spiral casing under full pressure. The brake is water cooled.

BUTTERFLY VALVES—Each turbine has its own independent pipe line, running from the forebay where are located motor-operated gate valves, so that gate valves for each turbine are not needed in the power house. However, for a quick closing of the water supply in case of accident it was found desirable to have some means of shutting off water from the turbines quickly. For such a purpose, a butterfly valve is satisfactory, provided it can be designed to be sufficiently tight to enable inspection of the interior of the entire turbine.

A cast-steel butterfly valve of 84-in. free-passage diameter has been placed below the main floor and connected between the tapered inlet pipe and the spiral casing. Since the valve is to serve as an emergency means of shutting off water from the turbine casing, it has been built to withstand full head and it can be closed or opened under full pressure. The gate has carried a total load of over 2,000,000 lb. at 385-lb. per sq.in. test pressure. The gate can be hand-operated or worked by a direct-current motor controlled at the turbine or from the switchboard. A bypass valve may be opened for filling the turbine casing, after the valve has been closed, to balance this gate. After balancing, the valve can be opened quickly by high-speed gearing of the motor.

GOVERNING DEVICES — Economy of water is a main consideration in the operation of this power plant, so that it is logical to regulate the supply of water to control the load fluctuation on the system. Special attention had to be paid to speed regulation, economy and reliability, as this plant regulates for the whole system. The governing system consists essentially of an oil-feed governor sending oil under pressure against a piston in a regulating cylinder to open or close the turbine gates (guide vanes).

For successful regulation, all influencing conditions must be studied. A governor of the best type and workmanship, wrongly applied, will operate less satisfactorily than a crude affair employed more correctly. Large columns of water flowing at high velocities under high heads offer a much more difficult problem than do low heads and short lines, or open-flume turbine settings.

One of the most important factors is the flywheel effect of the rotating masses. For a given speed variation, the motion period of the turbine gates can be lengthened as the flywheel effect is increased; the slower the gates are moved the more moderate will be the change of velocity in the pipe line and consequently the more moderate the pressure rise when load is thrown off, or the pressure drop when load is thrown on. The longer the pipe line or the higher the velocity of the water, the more severe will be these pressure variations.

It is easy to correctly figure speed changes for certain load changes with a given flywheel effect based on a certain closing or opening time of the gates, and the figures may not seem high enough to interfere commercially, yet it may still remain uncertain whether the governors can hold a constant load without setting up periodic oscillations of turbine speed as well as pipe-line pressure.

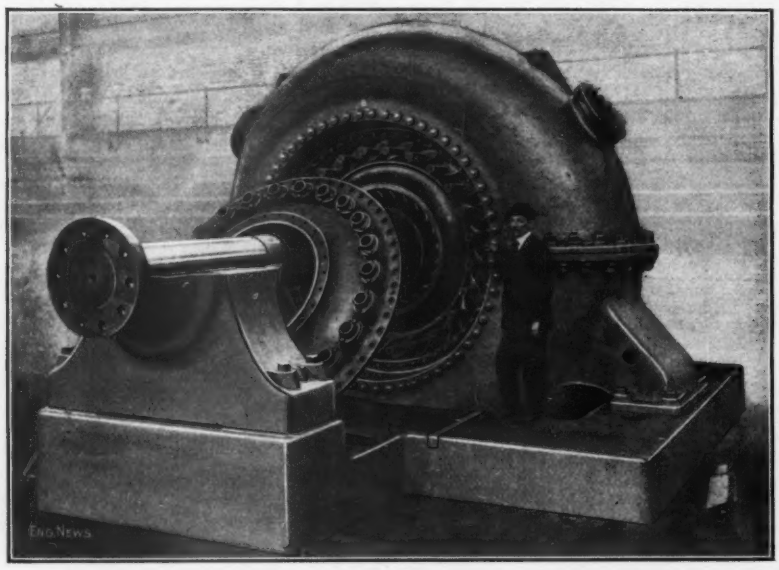


FIG. 4. VIEW OF 18,000-HP. FRANCIS TURBINE, SHOWING GUIDE VANES IN PLACE

A number of instances can be cited where failure to secure a harmonious relation between head, length of pipe line, velocity of water, flywheel effect and load changes has resulted in commercially unsatisfactory speed regulation, great financial loss and even surrender to competitive power producers. It is particularly necessary to select carefully the characteristics of one primary element—the speed control of the governor itself.

The governor adopted here is a type with the familiar flyball lift of a floating lever carrying the regulating-valve stem compensating relay and a motor attachment for switchboard control. The governor regulating valve is double acting and hydraulically balanced so that practically no energy is required to raise or lower the valve stem. The fly balls are extremely sensitive but still release considerable energy so that the smallest speed variation will move the control valve. A speed variation of ⅛ of 1% is sufficient to cause a motion of the turbine gates. The regulating valve is returned to its middle position after each movement of the compensating relay acting on the other end of the floating lever.

The desired maximum speed difference between friction load and full load can be set for any point between 0 and 4%. The former, however, is not permissible with alternating-current generators running in parallel with each other, as the lack of speed variation would cause a hunting of the load between the interconnected generators. To limit the maximum gate opening of turbines when regulated automatically, the governor control-valve stem is prevented from dropping below a certain fixed but adjustable position.

The gate-regulating cylinder is mounted horizontally on the main base plate with a bracket under the cylinder and the other under the crosshead guide. The piston rod projects through front and rear heads so that equal oil displacements are secured which allows of a simple bypassing of the oil when the hand regulator is used. The piston-rod extension through the rear (away from wheel) cover carries a gate-opening indicator. The other extension goes to a crosshead in guides which receive the thrust of the connecting rod between crosshead and first gate lever at end positions.

For inspection or repair of oil piston or governor without shutting down the whole unit, a hand screw is placed above the cylinder and connected with the first gate lever so that it can be conveniently thrown in or out of connection. In power systems of this size and with very large generators, it is permissible to have one or more units operating on a line without taking part in the automatic speed regulation, so that such a hand regulator is of commercial value.

PRESSURE REGULATORS—To protect the pipe line and to assist the governor, serious surges in the water column must be prevented. Inertia in the water column has been overcome in three ways at this plant: (1) There is a compressed-air cushion in chambers outside the power house connected to each penstock; (2) two 30-in. relief valves are connected to each turbine casing, one of these being opened by the governor to bypass water when the speed gates are closed and closing thereafter gradually at a predetermined adjustable rate; (3) breaking plates which are provided to give way in case of failure of either of the other devices.

Both relief valves consist of a main valve and an operating mechanism. The main valve is identical in both cases. A Y-pipe is connected to the bottom of the spiral casing below the generator floor, the branches of the Y leading to the relief valve. The neck of the Y is also con-

nected to a hand-operated gate valve (normally open) which is closed at its lower end by the breaking plate between valve body and discharge pipe. The discharge from the two relief valves unite in a steel-plate elbow to economize space between draft tubes.

The body of each relief valve consists of an elbow which, at its lower joint, holds a circular bronze-bushed ring against which is pressed a flared disk on a stem connected to a piston in a bronze-bushed cylinder above and extending through guides below. The shape of the disk valve and discharge ring is such that when the disk is lowered the discharge tends to spray, effectively reducing impact.

Water pressure on the disk tends to open the valve but it is counteracted by pressure below the control piston. Adjustment of this pressure for motion of the disk is secured by a regulating valve which receives its operating water from the main pipe line through a pair of duplicate cylindrical screens. Main-line pressure can be directly thrown below the main piston so that the relief valve may be held closed while the regulating valve is removed for repair or opened up for inspection.

The arrangement of these operating devices on the relief valves may be seen from Fig. 5. On the governor-actuated valve, a horizontal shaft is held in bearings cast integral with the cylinder cover. One end of this shaft carries a lever, which is connected to a reach rod from a gate-shifting bell crank. On the center of the same shaft is a forked lever carrying an oil dashpot on pivots. This dashpot contains a piston, the stem of which is connected to the outer end of a floating lever. The opposite end of this lever receives its motion directly from the disk valve, while the middle part of the lever is connected to the regulating-valve stem. The oil dashpot has an adjustable bypass. When the turbine gates are closing slowly, due to a gradual reduction of the load, the dashpot cylinder is lifted slowly and the oil in the dashpot is merely bypassed; the floating lever is not moved. If, however, the gate motion of the turbine is quick, due to a sudden reduction of load, the oil is not bypassed quickly enough and the floating lever and the regulating valve are lifted. The pressure below the operating piston is thereby reduced and the relief opens. However, this movement of the disk has lowered the other end of the floating lever, so that the regulating valve is brought back toward its closed position and the relief disk is held balanced. Due to the slow bypassing of the oil in the dashpot, the piston therein moves slowly downward, closing the regulating valve and causing a corresponding closing of the relief. This closing time is determined by the amount of oil bypassed in the dashpot and is adjusted individually for each unit, according to the condition in its pipe line; the main consideration in adjustment is not to close the relief valve so quickly that a secondary pressure rise is caused in the pipe line.

From the foregoing it is obvious that, if the bypass is completely closed and if the relief valve has a discharge capacity equal to that of the turbine, the governor attachment allows this valve to serve as a water-wasting bypass with which the velocity in the pipe line is held practically constant, no matter whether the turbine discharges its full amount of water or whether the speed gates are closed and the relief is wide open. Simple regulation of the amount of oil bypassed enables a change from water-wasting to water-saving operation even during operation of the turbine, and this has been found valuable in plants where oscillations may be set up through wave interference, under severe pipe-line and load changes—troubles which are effectively subdued by a temporary wasting of

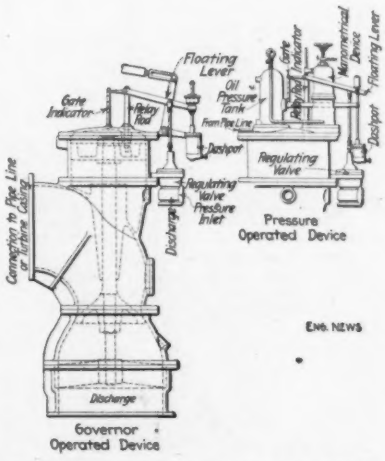


FIG. 5. PRESSURE REGULATORS OF 18,000-HP. FRANCIS TURBINE

water to maintain a constant velocity. With very long pipe lines or very high velocities, the pressure regulator must be operated as a water-wasting bypass; but when the turbine speed gates are closed the disk valve will be wide open, and it may become dangerous to close the head gates; a handwheel has been put on top of the dashpot-piston rod to allow a preliminary gradual closing of the relief valve.

If the handwheel is left at ¼, ½ or ¾ full travel, then the bypass will be closed at ¾, ½ or ¼ opening of the turbine gate. This is desirable whenever the maximum load of the turbine expected for certain periods of service is less than full, and where it is desired not to waste the full amount of water.

It is seen that the governor-operated relief valve controls pressure in accordance with the gate motion of the turbine to which is it connected, but any disturbance of pipe-line pressure, caused independently of speed-gate motion, is not controlled by this device, and such disturbances are taken care of in the second relief valve. Experience has shown, however, that the pressure-operated relief valve cannot function as correctly as the governor-actuated, and it is therefore advisable to set the former to open only under such pressure rise as might endanger the pipe line; and at any rate it must not close quickly to cause a secondary rise and reopening. Incorrect operation of relief valves has often interfered with the governor action and even led to destruction of a whole plant.

The pressure-actuated control used here comprises a cylinder and piston under pipe-line pressure and balanced by compression of a strong spring. The piston rod goes to the center of a floating lever, the outer end of which moves, through a dashpot, the regulating valve. The inner end is connected to the relief-disk stem. Pressure rise causes an upward motion of piston and regulating valve, which drops the relief disk. Motion of the latter restores the regulating valve to mid-position and holds the disk balanced. The dashpot between floating lever and control valve allows a gradual closing of the relief valve similar to the governor-actuated device described already.

To prevent silt from interfering with the sensitiveness of this control, the water pressure is not directly admitted to the manometric cylinder, but it is carried into a pressure tank filled with oil, which is led against the control piston.

CENTRAL OIL-PRESSURE SYSTEM—As this plant will take the principal load fluctuations of the company's whole power system, it is necessary to provide a larger supply of oil under pressure for the governors; in this system reliability and simplicity are of vital importance, overruling considerations of efficiency. Three rotary pumps have been installed, each with a normal capacity of 20 gal. per min. against a pressure of 400 lb. per sq.in. Two are directly coupled to 65-hp. induction motors, and the third is coupled to such a motor on one end and to a small impulse water wheel on the other. The pump is a two-stage gear type. Space was available in the powerhouse basement for pumps, pressure tanks and receivers, and these are assembled in a compartment below the generator floor. All pipes to and from the governors and equalizing pressure tanks are carried directly below the main floor through basements, which are easily accessible. The three pumps are set with the driving shafts in line and provision is made for a fourth pump, which will be required for the ultimate number of turbine units. The pumps in the center are built symmetrical and the auxiliary impulse wheel between them can be coupled to either of the two shafts, as needed.

There are two independent steel receiver tanks partly set in the basement floor, so that oil is received by gravity. The inflowing oil has liberal contact with air and discharges over a screen to clear and cool itself. The receivers are interconnected and each is of ample capacity so that one is capable of carrying oil for the whole system, while the other is emptied for cleaning. On a concrete pier between the two receivers are two main pressure tanks of riveted steel plate, tested to 600 lb. per sq.in.; each has a capacity of about 250 gal. An adjustable safety valve is attached to each and discharges directly into the receiver. This safety valve can be tripped from the outside, so that an operator can see if it is "free and sensitive."

The piping between the pressure and receiving tanks is arranged so that any combination of connections can be established to quickly cut out any part of the system. The pipes are of 4½-in. annealed seamless steel tubing, with bends of at least 12-in. radius. All connections are made with flanged joints. All piping exposed above the main generator floor is brass, as are valves and fittings throughout. The ends of the oil-supply pipe carry two auxiliary pressure tanks to prevent serious drop of pressure due to the acceleration of the oil in the long line between pressure tank and governor. The two main and the two auxiliary pressure tanks are inter-connected by an air pipe and also connected to a small air compressor located in the basement.

EXCITER UNITS—Two exciter units have been provided. The wheels of each are of the impulse type with hand needle regulation and governor-operated deflecting hood. Each wheel is designed to develop 500 b.hp. under 420 ft. effective head, with a normal speed of 400 r.p.m. A runaway speed of 800 r.p.m. has been designed to be withstood. Since close speed regulation is accomplished exclusively by the deflecting hood (operated by governor) and since economy of water was not essential with these small units as with the main unit, a simple hand adjustment of the needle was considered sufficient. The hood proper consists of a forked lever hinged below the nozzle and carrying a removable knife-edged blade. This blade cuts into the jet from underneath in such a manner that the entrance edge is parallel to the axis of the jet. By this arrangement the upper undeflected portion of the jet impinges on the buckets undisturbed, while the lower portion is deflected into the bottom of the wheel pit against a removable steel plate baffle lining. The shaft of the deflecting hood projects through the wheel housing above the floor so that it can be directly connected to the governor.

The exciter governor is a self-contained oil type not connected to the central pressure system, but furnishing its own oil pressure. This scheme enables independent operation of the exciter unit so that the field current can be held constant on the generators irrespective of the condition of the governors of the main units.

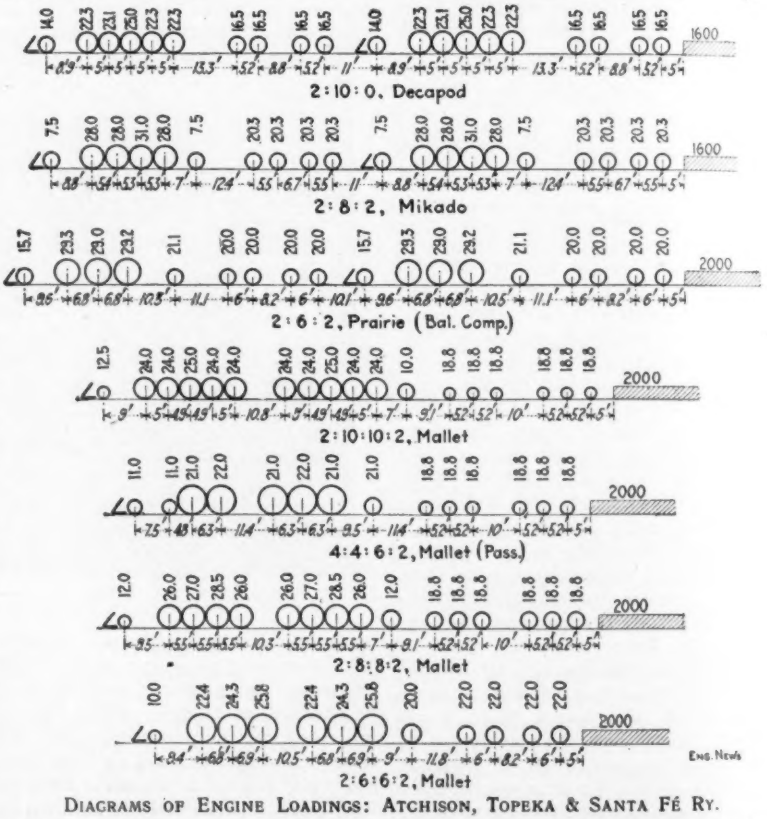
The White River development was made by the Stone & Webster Engineering Corporation, of Boston. The hydraulic equipment described above was furnished by the Allis-Chalmers Co., of Milwaukee, and the electrical apparatus was very largely built by the General Electric Co., of Schenectady, N. Y. The contract for the hydraulic equipment was signed in November, 1910. The first main unit and all exciters and apparatus were shipped in June, 1911, and were ready for commercial operation Oct. 31.

The equipment was turned over to the operating staff Mar. 1, and is now regulating the whole power system exclusively. Periodic load variations of about 3500 kw. are taken care of by the governors. In order to keep the speed regulation within close limits the governors, of course, have to adjust more than the load fluctuations of the system and it can be noticed that these governors change the gate opening of the turbines between 0.3 and 0.4 of the full amount during such variations. The pressure regulators prevent any rise in penstock pressure exceeding 9 lb. above normal when full load is suddenly thrown off, and the air chambers now connected with the pipe lines furnish that amount of water which cannot quickly be received by acceleration when load is thrown on. The effect of these air chambers is extremely beneficial.

The machines now carry a full-gate load of 15,500 kw. (20,800 hp.) each under 440 ft. effective head; and from a dead short-circuit to no load, which requires a full gate motion by the governor from wide open to closed, the maximum speed does not exceed 395 r.p.m., or about 10% above normal.

Relation of Heavy Mallet Locomotives to Bridge Stresses

With the extensive adoption of the Mallet type of locomotive by American railways, there has been some question as to whether existing bridges are strong enough to carry the enormous concentrated loads without undue stress or rapid



DIAGRAMS OF ENGINE LOADINGS: ATCHISON, TOPEKA & SANTA FÉ RY.

(Wheel loads are given in 1000 lb. for one rail. Uniform train load is given for one rail. Distances are given in feet.)

deterioration. There seems to be no cause for apprehension on this score, however, especially when it is considered that in many cases the single Mallet engine takes trains which formerly required two engines of the ordinary type, the trains being commonly handled as double-headers. Thus the comparison is not between the Mallet engine and a single engine of the ordinary type, but between one of the former and two of the latter. It is to be remembered also that while the total weight of the Mallet

TABLE I. CENTER MOMENTS AND END SHEARS OF BRIDGES FOR VARIOUS ENGINE LOADINGS: A., T. & S. F. Ry.

Span ft.	(A) Mallet, No. 3000 2:10:10:2		(B) Bal. comp., No. 1800 2:6:2		(C) Standard Loading A., T. & S. F. Ry.		(D) Cooper's E-60	
	Moment	Shear	Moment	Shear	Moment	Shear	Moment	Shear
30	553	82	458	72	477	71	616	95
40	867	99	733	84	727	82	983	113
50	1,265	120	1,044	96	1,021	93	1,426	131
60	1,872	141	1,395	110	1,372	102	1,949	147
70	2,445	158	1,848	122	1,767	116	2,560	166
80	3,100	174	2,358	134	2,213	131	3,241	186
100	4,635	206	3,595	162	3,202	154	4,830	225
150	9,318	267	7,687	230	6,742	206	10,573	313
175	12,021	304	10,011	261	8,801	230	14,040	351
200	14,956	333	13,391	291	11,227	252	17,775	393
250	22,064	426	17,996	348	16,311	296	26,340	470
300	30,452	480	27,404	401	21,908	335	36,612	542
350	38,420	533	36,432	454	25,732	373	49,908	625
400	46,388*	561	45,459	509	35,937	421	63,204	700

(A) One engine and 4000 lb. per ft. trainload; *with 4800 lb. per ft. the moment on 400-ft. span is 52,426.
(B) Two engines and 4000 lb. per ft.
(C) Two engines and 3200 lb. per ft.
(D) Two engines and 6000 lb. per ft.

engine is very great, its axle load is likely to be even lower than that of the engines with which it is compared. However, the great concentrated weight may involve the strengthening of certain structures, in order to insure economical life and service of such structures, but this additional expense is considered as being well warranted by the economies in operating expenses which are effected by the use of engines of the Mallet type.

We have made some inquiry recently as to the conditions on roads which are extensive users of Mallet engines, and present herewith the information that has been obtained.

Atchison, Topeka & Santa Fé Ry.

In Table I are shown the center moments and masonry reactions of different loadings, including Mallet engines and the present standard bridge loading, while Table II gives a summary of some of the features of loading by different classes of engine. The accompanying cut shows the wheel spacing and loading of some of the engines mentioned. It may be noted that the 2:6:2 (Prairie) engines are balanced-compounds having a load of about 175,000 lb. on the drivers; this is uniformly distributed, there being less than 1000 lb. difference in the weight on the individual axles. The maximum single-axle load on the Mallet engines will go somewhat above the maximum for the 2:6:2 class; but it does not exceed 60,000 lb. The following particulars are from a statement furnished us by A. F. Robinson, Bridge Engineer of the A., T. & S. F. Ry. system.

So far as the floors of truss spans and moderate length girder spans are concerned, the increase in unit stresses probably will not be serious. But for spans from 175 ft. upward the increase in stresses in chords may cause some trouble. It is generally assumed that the unit stresses in the trusses of a modern span may be increased 50% to 60% over the unit stresses used in original design. This increase in unit stress will undoubtedly shorten the life of the bridge. Just how much this will be we do not know, as yet. We have spans from 150 to 260 ft. on the lines where these Mallet engines are running, and up to the present time they do not give any indication of excessive stresses. Where these engines are to run, we are rebuilding or reinforcing, as rapidly as necessary, bridges having spans above 260 ft. However, the districts where these engines are now running and where we expect to run them have a relatively small number of bridges that will be seriously affected. Very few roads have many spans above 200 ft. in length.

Concerning steel viaducts, we have only four of these on the portion of our lines over which Mallet engines will be operated. These are old structures which were either reinforced or rebuilt some years ago, bringing them practically up to the requirements of our standard loading. As to stresses in longitudinal bracing, the towers in all our viaducts are designed to take the full tractive effect of the standard loading in one tower, assuming 20% as the coefficient of friction. In the longitudinal bracing in viaduct towers I have always used angles considerably larger than the stresses actually required. This because of the liability of these members being struck by material falling from passing trains.

So far as concerns pile bridges and timber trestles, the longitudinal and transverse bracing which we have always provided in our standard structures is ample to meet the requirements of the Mallet engines. One point which is of material advantage in view of the use of these heavy engines is the very large number of ballasted deck bridges on our line. It will be readily appreciated that a heavy ballasted floor will assist very materially in stiffening up the structures under these heavy loadings.

Undoubtedly the use of this heavy power equipment on our standard spans above 150 ft. in length will shorten their life, but it is not expected that it will be necessary to rebuild these spans for a good many years. Perhaps the first structures that will require replacement are spans above 200 ft. in length. It is expected that the saving in operating expenses resulting from the use of these Mallet engines will fully warrant the replacement of the few spans above 150 ft. whenever they wear out. It may be added that in rebuilding any of these spans we are using a loading at least equal to Cooper's E-60.

Several years ago it was found that the usual assumption as to lateral loading did not give structures sufficiently rigid laterally under our heavy fast service. The ordinary assumption as to wind load has been 300 lb. per lin.ft. on the loaded chord, with 150 lb. per lin.ft. on the unloaded chord. After careful consideration, we assumed a minimum lateral load of 1000 lb. per ft. of span, 700 lb. of this to be applied at the loaded chord. This has given structures which show a good deal more lateral rigidity than is given for spans designed under the ordinary assumptions.

TABLE II. CHARACTERISTICS OF DISTRIBUTION OF ENGINE LOADING, A., T. & S. F. RY.

Engines	Weight		Driving wheelbase		Driving axle loads	
	Total tons	On drivers tons	Total ft.	Load per ft. tons	Max. tons	Ave. tons
2:6:2, No. 1800	124	87½	13½	6.5	29.3	29
2:8:2, Mikado	130	115	16	7.2	31.0	28
2:10:0, Decapod	129	115	20	5.7	25.0	22
2:6:6:2, Mallet	175	145	34½	4.3	26.0	23
2:8:8:2, Mallet	239	215	43	5.0	28.5	26
2:10:10:2,* Mallet	264	242	51	4.7	25.0	24
4:4:6:2,† Mallet	150	107	30	3.6	22.0	21

*No. 3000. †Passenger service.

Other Railways

Chicago, Burlington & Quincy Ry.—The general reinforcement of bridges on this road was undertaken about 16 years ago, and at that time the loading adopted was sufficient to provide for any motive power which has yet been built. On such lines as were not thus improved, it has been necessary to make some changes, but these have not been extensive and consisted generally only in strengthening the floor of timber trestles. In one case it was necessary to make some reinforcement of the Missouri River bridge, having spans of 375 ft.; this was done without interruption to traffic and at a moderate cost. But for the most part the heaviest power equipment is placed in operation without making any material changes to bridges.

Chicago Great Western Ry.—The bridges are designed generally for Cooper's E-55 loading, which has been sufficient to take care of the Mallet type engines.

Northern Pacific Ry.—This road has a considerable number of Mallet engines in regular use on the system, and does not find that they are materially harder on the bridges than a double-header of heavy compound engines of the 2-8-2 class. These latter weigh approximately 231 tons, against 295 tons for the heaviest Mallet type, including the loaded tenders.

Southern Pacific Ry.—Engines of the Mallet type are being used between Sacramento and Sparks almost to the exclusion of any other class. Practically no reconstruction of bridges, trestles or track was undertaken prior to the introduction of these locomotives, or have been done since their adoption some few years ago. The standard specifications for trestles, bridges or other structures, which have been in use for many years, are entirely sufficient to take care of the weights involved by the Mallet engines.

Failure of an Air-Pressure Water Tank at Jessup, Iowa

Some months ago there occurred at Jessup, Iowa, the first failure of an air-pressure water-supply tank which had then come to our attention. After considerable correspondence we obtained several reports of the failure from different persons, which we give herewith in whole or in part. It should be added that the delay in publishing this matter is not the fault of our informants.

J. W. Bagenatos, city marshal and superintendent of water works, wrote us on Sept. 28, 1911, as follows:

"The tank exploded at 9:40 a.m., Sept. 1. It was 8 ft. in diameter and 36 ft. long, and the shell was ⅝ in thick.

"The pressure at the time of the explosion was between 50 and 60 lb. I usually pumped from 65 to 75 lb.

"I think the pipe was weakened by natural wear and rust; also think there was a flaw in the steel plate."

Ralph B. Slippy, an engineer of Waterloo, Iowa, wrote us on Oct. 18, 1911, in reference to an inquiry:

"I had occasion to visit Jessup a short time after the accident to the water tank. The tank was a cylindrical steel tank, 8 ft. in diameter, set horizontally on a concrete foundation. There was a cast-iron manhole 3 or 4 ft. from one end. It was supposed to be able to carry a constant pressure of about 65 lb. per sq.in., and had been in service 10 or 12 years. The pressure was supplied by an air pump, impelled by a gasoline engine. The engine and tank were inclosed in a small brick building. The safety valve had been out of order for some time and it was the custom of the engineer to start the pump and pump a few hours each day until he had about what he judged to be the right pressure. On the day of the accident he had started the engine and left the building a very short time before the explosion occurred. The explosion ripped the steel shell (about ¼ in. in thickness) almost the entire circumference. The line of rupture passed through the cast-iron manhole, followed a line of rivets a short distance and the remainder of the line was in the steel plate, the direction being nearly parallel to the end. The explosion completely demolished the building, but there was no loss of life or other damage.

"It is probable that the tank was not designed for a very high pressure and that through the failure of the safety valve to work properly the pressure was allowed to become too great.

"When the tank was first constructed, it was intended to supply water for fire protection only. Of late years there has been a constantly increasing demand for water for domestic use in the town and I understand that the service was very unsatisfactory on account of the variation in pressure, caused, of course, by the small capacity of the tank.

"Tanks of this kind are not very numerous in this section, at least for municipal water systems. The elevated tank or standpipe is much more used. I know of no other town in this vicinity with an air-pressure tank."

Still another account of the failure, also by an outside engineer who had been on the ground, has been obtained for us by Prof. A. Marston, dean and director of the Division of Engineering, Iowa State College, Ames, Iowa. On Oct. 18, 1911, Prof. Marston wrote us as follows:

"I have been in correspondence with one of the alumni of this institution, who has charge of the water-works contracting department of a large engineering and contracting firm which has a contract for erecting a steel tower to replace the exploded tank. This firm sent a representative to investigate the failure, and my friend kindly supplies the accompanying sketch and the following data of the explosion:"

This tank was installed in 1902, and at that time the tanks were built of much lighter plates than are commonly used at the present time. It appears that the superintendent of the plant left the building and at the time he left the pressure in the tank was 50 lb. per sq.in., and the water pump was in operation. He was gone about five minutes when the explosion occurred, so that the pressure at the time of the explosion did not exceed 60 lb. The superintendent was just returning to the building when the explosion occurred and, therefore, witnessed it. He states that the tank raised up on one end, tearing the roof of the building away and demolishing the building in general, and then settled back to a horizontal position. The end of the tank which raised was the damaged end, which, of course, would be expected. The inside of the tank plates gave no evidence of having been painted, and was very badly pitted.

There are a great many tanks of the same size and thickness of plates in use throughout this territory, and it is only a question of time until other explosions will occur. This tank was supposed to have been tested to 100 lb. pressure when installed, and was suitable (?) for a 65-lb. working pressure. I think if you will figure up the stresses caused by the 65 lb. pressure, that you will find the metal very highly stressed. A similar explosion occurred at Hartford, S. D., about two years ago, and the damage to the building and machinery was almost entire.

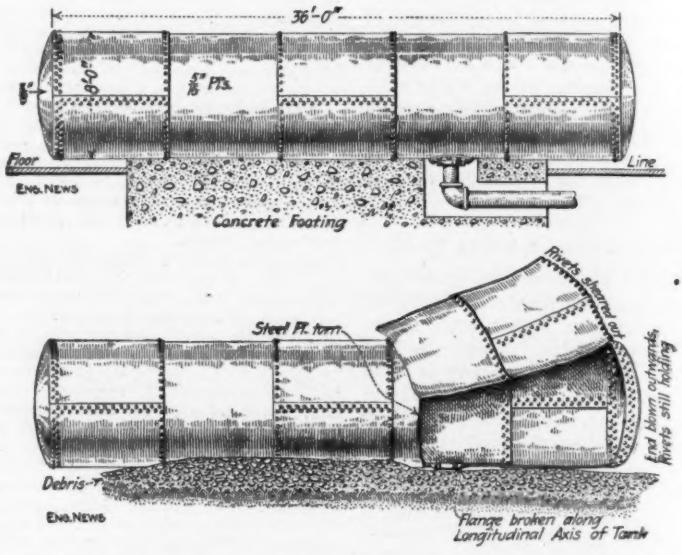
Continuing, Prof. Marston writes:

"I understand that several air tanks have recently been replaced by elevated steel tanks, although I must confess that I do not have particulars as to any other instance except the one at Jessup."

In an earlier letter, writing on the general subject of air-pressure water tanks, Prof. Marston said:

"There are quite a number of these plants in this part of the country. I think that their principal fault is that they have so little storage capacity as to be of little value in case of a fire of any magnitude, and I have always been unfavorable to their use unless a storage capacity was provided equal to that which experience has demonstrated to be necessary for elevated tanks in this region. An air-pressure plant having this amount of storage capacity would be so expensive in comparison with elevated tanks that the latter are nearly always preferred.

"A company pushed the air-pressure plants in this vicinity a few years ago, however, and had a very able representative, who succeeded in convincing quite a number of councils that the air-pressure plants were all right."

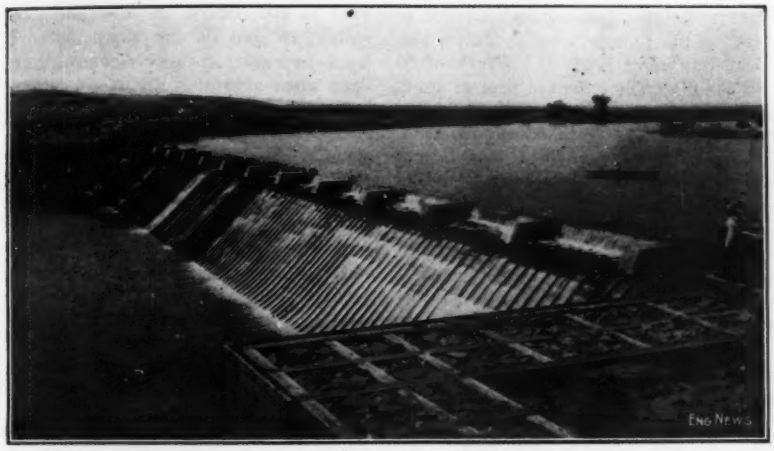


SKETCHES OF WRECKED AIR-PRESSURE WATER TANK AT JESSUP, IOWA

The Dodson Timber and Concrete Dam, Montana

A dam consisting of timber cribs between concrete piers, with steel rails to protect the downstream timber face from ice, and with provision for a needle superstructure, is shown by the accompanying view. The dam, which was completed several years ago by the U. S. Reclamation Service, forms a part of the Milk River Project, in Montana.

Between the abutments shown in the view the dam has a total length of 318.12 ft. Thirteen concrete piers, 36 in. wide at the bottom and 22 in. wide at the top, divide the total length of the structure into 15 spans, of which the two end ones are 21.06 ft. from the center of the pier to the abutment and the other 13 are each 23 ft. c. to c. of pier. The spaces between the piers and between the end piers and the abutments are filled with timber and rock, the timber being secured to the piers by anchor bolts. The upper face of the dam is planked. The lower side is faced with heavy timbers, protected with rails, as already stated, and as is shown by our engraving.



THE DODSON DAM, MILK RIVER PROJECT, U. S. RECLAMATION SERVICE, MONT.

We are informed by F. H. Newell, director of the U. S. Reclamation Service, that the piers were designed for the future attachment of a movable top.

A Water Supply from an Abandoned coal mine has just been introduced in the city of Oldham, England. Two abandoned collieries having a combined drainage area of 1176 acres are used for the supply and it is estimated will yield a million gallons a day. An adjacent colliery with an area of 389 acres will become available in about two years. The water which collects in the abandoned workings drains to a sump from which a deep mine pump elevates it to a height of 429 ft. to an underground storage reservoir with a capacity of a quarter of a million gallons, constructed of reinforced concrete. From this reservoir the water is raised 325 ft. to a distributing reservoir, a total lift of 754 ft.

British Tests of Road Materials

Apparatus for testing road materials has been installed by the National Physical Laboratory of England, in connection with the work it is doing in coöperation with the British Roads Board. The apparatus was described in a recent annual report of the Laboratory and the description was abstracted in the London *Surveyor*, of Mar.29.

Mention is first made of four pieces of apparatus used by the U. S. Office of Public Roads and purchased in order to obtain results comparable with those available in this country: (1) A four-cylinder abrasion machine of the Deval type; (2) a Page impact machine; (3) a Dorsey hardness machine; (4) a standard penetrometer. The first three of these were bought from Riehle Brothers, Philadelphia, and the fourth from Howard & Morse, Philadelphia.

Endurance tests are to be made on specimen roads, as follows:

In these tests the specimen road to be tested is laid in the form of a circular track 2 ft. 6 in. wide of a mean diameter of 34 ft. The endurance of the center 2 ft. of this track is tested by the rolling on it of eight 3-ft. steel wheels, the wheels being at an angular distance of 45° from each other, and each wheel rotated by a separate 2 b.hp. electric motor mounted on a steel arm, which revolves round the center post. The radial distribution of the wheels is such that the whole width of 2 ft. is covered in one revolution of the arms, and as a further precaution to ensure uniform wear each wheel is moved backwards and forwards radially by a cam mechanism through a distance of 1 in. The eight arms are all hinged to a rotating boss on the center post, and at their outer ends are connected by spiral springs to eight corresponding cantilevers rigidly fixed to a second rotating boss connected with the former and immediately below it. By means of a regulating wheel on each spring the pressure of each wheel on the track can be adjusted to any desired value up to one ton. The armatures of the eight motors are connected in series, the maximum voltage over all the machines being 440 volts. The main current is supplied from a motor generator through two slip rings on the center post, and the shunt-field coils of the motor are connected in series, and supplied direct from the supply mains through two smaller slip rings.

It is estimated that, in the case of a road of tar macadam, by the use of solid steel wheels running at 10 miles per hour, 24 hours' continuous running would represent one year's wear on a typical heavily trafficked road. The machine will, of course, be available for endurance tests of rubber-tired wheels at the higher speeds which can be attained up to 25 miles per hour.

The *Surveyor* comments editorially on the endurance tests as follows:

As regards the "whirling table," the particulars given have formed the basis of some calculations which we have made, these calculations pointing to the probability that the centrifugal forces set up will be insignificant as regards the theory of the apparatus, though it may turn out that to overcome their effects in matters of detail may take some little time and attention. As regards the main effects of centrifugal force, we do not find that it is likely to produce any effect at all corresponding to that produced when a motor car is driven round a bend at a high speed, though the machine could, no doubt, be adjusted so as to imitate this effect if desired. Any downward or upward component introduced by depressions or bumps in the wheel path would, we believe, be quite insignificant. As regards the value of tests such as those which can be carried out with this machine, it is difficult to believe that they can be made representative of actual traffic conditions, especially if they are carried out at an only slightly varying temperature in the case of tar-bound crusts. With water-bound crsts it will be impossible to put the materials through even a few of the phases of dryness and moisture which would occur with the lapse of the corresponding period of time on the road. If, however, the machine be regarded as in the same category as an abrasion machine, it ought not to be impossible to obtain results which would compare with one another and give valuable information.

On the whole, we are inclined to think that the whirling table, which to some extent reproduces the wheel effects of vehicles, will be more useful in giving us information about the direct effects of wheel loads, wheel diameters, tire widths, and speeds of vehicles than it will be with respect to the ultimate effects upon roads as indicated by the state of the greenhouse path on which these wheels will run. In this matter the time element is, perhaps, the greatest difficulty of all. It is probably intended to test chiefly tar-bound crusts, but even those require time for setting. Road crusts are often subjected to traffic as soon as they have been put down; but not to the normal traffic multiplied by 365. The statement that the whole width of 2 ft. will be covered in one revolution of the arms does not call for criticism now, since the procedure suggested can obviously be modified in the direction of a practical experiment, and with a path 4 ft. or 5 ft. wide, rut experiments could be made very interesting.

Wood Block Paving with Cement Filler*

By A. J. Schafmayer†

The use of creosoted wood block in the construction of pavements in Chicago has been steadily increasing for the last few years. While this pavement is successful in general, it is still somewhat in the experimental stage with respect to certain details: (1) the method used to prevent the blocks from bleeding, or exuding tar and oil; (2) the method of providing for expansion, and (3) the type of filler. It is the purpose of the writer to present certain features of a creosoted wood-block pavement with which he was connected, and which was laid in 1911 on Lake Ave., from Oakwood Boulevard to Hyde Park Boulevard.

The first pavement of this kind in Chicago was laid on Michigan Ave., in front of the Auditorium Hotel. According to the recent report by John Ericson, city engineer, this was laid by the South Park Board in 1900, as a sample pavement without specifications. The blocks were set on loose cement. The joints were filled with cement grout, and expansion joints 1 in. wide were provided along the gutters only. The blocks were made from long-leaf yellow-pine timber treated with 16 lb. of oil of specific gravity 1.03 to 1.06; from 50 to 75% of the oil evaporated at 315° C. The courses were laid at an angle of 45° with the center line. No bleeding of the blocks occurred and no trouble with the expansion of the blocks was experienced. In 1910, the alley between 48th Place, 49th St., Grand Boulevard and Vincennes Ave. was paved with similar blocks set on 1 in. of sand. The treatment consisted of 16 lb. of oil with a specific gravity of 1.10 and with not over 40% evaporation at 315° C. The courses were laid at 45°. Expansion joints 1 in. wide were placed at the curbs, and ½-in. transverse joints every 25 ft. The balance of the joints were filled with cement grout and a great deal of trouble was caused by expansion but no bleeding occurred.

Until the paving on Lake Ave., these were the only creosoted block pavements filled with cement grout. On the other hand, many had been laid with pitch or sand fillers, and some of these, being in the near vicinity of the Lake Ave. improvement, exercised considerable influence in the choice of this pavement. These were laid with a pitch filler, and a slight amount of trouble from expansion was experienced on Kenwood Ave. only. More or less trouble developed, however, on each of them from the bleeding of the blocks in hot weather, and pitch accumulating on the surface and sticking to the shoes of pedestrians. On 49th St. this became so bad that it was necessary to scrape the surface of the pavement at two different times.

About this time the improvement of Lake Ave. was being agitated and the residents were familiar with the situation mentioned. They favored the creosoted block paving, but in the hope of avoiding an excess of pitch on the surface, and because of the success of the Michigan Ave. pavement previously mentioned (and successful experience as reported from other cities) a cement-grout filler was provided.

The blocks were to be 3¼x4 in., and 6 to 12 in. long, made from long-leaf yellow-pine, tamarack, or black gum. They were to be treated with 16 lb. of oil with a specific gravity of 1.10 to 1.13 at 25° C., and a maximum distillation of 40% at 315° C. Tests showed 1.1264 to 1.1279. The courses were to be laid at 45°. Longitudinal expansion joints of 1 in. at the gutters were specified, and ½-in. transverse joints at intervals of 50 ft. The filler was to be 1:1 cement grout, and applied in two or more courses. The top dressing to be ¼ in. of torpedo sand. The specifications provided that if any excess of oil or pitch appeared on the surface (due to bleeding) within the guarantee period, the contractor should remove it or top dress the surface again at that point, within three days of receiving notice from the Board of Local Improvements.

A combined curb and gutter with 18-in. gutters, was built for a 38-ft. roadway between the curbs. A 6-in. foundation of portland-cement concrete was built on the subgrade, on which was spread a 1-in. sand cushion for the blocks. These were laid moderately close, but not driven tight. At this time it was feared that the expansion joints mentioned would not be adequate, and it was agreed to increase the width to 1¼ in. at the gutters and to make the transverse joints ¾ in. wide and 25 ft. apart. The street was paved for about 1000 lin.ft. in this manner, with the cement grout filler applied as provided in the specifications. Traffic was kept off for seven days and before the expiration of that time the blocks were up in ridges at many of the transverse joints. A couple of heavy rains, followed by very hot weather, increased the expansion until at some of the worst places the pavement had buckled up over a foot above the original surface.

We found that in almost every case the cement-grout filler had found a low place in the joint and had become set there, keying it open. There appeared to be two causes for this condition: (1) the pitch used to fill the expansion joint had subsided somewhat in cooling and left open a portion of the joint from ½ to 1 in. deep and from a few inches to a few feet in length; (2) the workmen, after removing the strip with which the joint is formed, placed small sand dams in the joint at certain intervals before pouring the hot pitch, to prevent it from running along the joint before cooling. These dams are supposed to be removed after the pitch has cooled and before the next interval is poured, but sometimes this sand is not entirely removed.

In either case, when the cement grout is swept over the surface it fills the part of the expansion joint not previously occupied by pitch, and when it has set it keys the joint open at that point. In the first case, it generally extends a few feet along the joint and keeps it open at the top while the blocks can come together at the bottom. This is apparently what happens when expansion occurs and the pitch squeezes out beneath the blocks while the joint comes up in a ridge. In the second case, the grout soaks into the sand to the bottom of the joint and wedges it open its full depth, but only for a very short distance along the joint. Then when expansion occurs the pitch is forced out on each side and the pavement around this wedge "blows up" in a formation somewhat dome shaped.

We noticed also that in expanding, the blocks moved along the courses beside each other, shearing the thin films of cement grout in the joints between them and shattering the bond of the cement. After the pavement had adjusted itself by moving in this manner a few days, the grout was scarcely any more impervious to water than so much sand. This demonstrated the futility of diverting the traffic from the street for seven days.

Repairs were made upon the buckled areas, and it was found that in places the curb and gutter had been forced back from the concrete foundation a distance of 2 in. and the expansion joints were entirely closed. When measuring the pavement after completion, the distance between curbs (originally 38 ft.) was 38.4 ft. at the point of greatest expansion.

Meanwhile construction was carried on with the same system of longitudinal and transverse joints, except that the width of the transverse joints was increased to 1 in., and that rigid care was exercised to see that all joints were filled flush with pitch and all sand dams removed. In addition, traffic was permitted upon the new pavement after the second day. This accelerated the shattering of the bond of the cement and enabled the blocks to move beside each other more freely. In this way a pavement was secured that buckled in only a few places. It was observed, however, that the blocks were under very great pressure and that the curbs were being forced back to such an extent that in front of carriage walks and of sidewalks at intersections, where an

*Abstract of a paper read at the annual meeting of the Illinois Society of Engineers and Surveyors, held at the University of Illinois, Urbana, Ill., Jan. 17-19.

†Assistant Engineer, Board of Local Improvements, City Hall, Chicago.

outward movement was obstructed, the back of the curbs was being sheared off or the walks were being broken and turned up at an angle.

It was decided, upon the suggestion of the contractor, to lay an experimental pavement one block long without the transverse expansion joints, as they appeared to be elements of weakness; and also to increase the width of the joints at the gutters to 2 in. As no trouble occurred, this plan was followed until the pavement was completed, making a little over a mile laid by this last method. In this distance only a very few "blow ups" occurred. At one or two intersections which were paved with asphalt the blocks forced the asphalt up in a ridge at the joint. This was partially due to the fact that as Lake Ave. is a diagonal street, some of the courses at the wings were very long and expanded in proportion. Only one case has been noted so far on this part of the pavement where the curb and gutter was thrust out far enough to shear off the back of the curb. At the present time the pavement appears to be in excellent condition. No bleeding of the blocks has occurred so far, but the most severe tests of this will come next summer.

Conclusions

The limited number of facts presented above seem to indicate three probable points for consideration between a cement-grout filler on one hand, and pitch or sand filler on the other hand.

(1) The use of a cement-grout filler seems to increase the amount of expansion to be provided for in designing the pavement. Assume a 35-ft. space between gutters, and courses laid at 45°. This gives a total length of the paving blocks at 8 in., making a total of 75 joints in one course. Assuming that with a pitch filler, $\frac{1}{8}$-in. expansion is available in each joint between adjoining blocks, there would be $4\frac{3}{4}$ in. available in the entire course. Practically none of this could be utilized when using a cement-grout filler. This difference would be decreased in comparing cement with sand filler, but it would still be of considerable amount.

(2) The use of cement grout in this case greatly increased the amount of care required in forming and inspecting the expansion joints to prevent the grout from getting in and keying them open. (3) But this filler also seems to reduce the annoyance caused by accumulations of pitch and oil on the surface.

Letters to the Editor

Matrimony and Pigs; A Problem

Sir—While the problem given below has very little to do with engineering, I would like very much to see a solution of it in your paper.

The problem: Three men went with their wives to market to buy pigs. The men's names were Hans, Jason and Peter and the women's names were Gretchen, Lisa and Susan. Each one buys as many pigs as he or she pays shillings for one pig. Each husband pays for his pigs 63 more shillings than his wife pays for hers. Hans buys 23 more than Susan; Peter buys 11 more than Gretchen. What is the name of each man's wife?

JOHN D. WALDROP.

Norfolk, Va., Apr. 8, 1912.

[The solution of the problem is dependent upon the integral qualities of a pig, and even then it cannot be reduced to algebraic rigidity. The key equation is

$$x^2 - a^2 = 63$$

where

x = Number of pigs one man buys,

a = Number of pigs his wife buys.

This equation has only three positive integral solutions, i.e.,

$$\left.\begin{matrix} x = 8 \\ a = 1 \end{matrix}\right\} \left.\begin{matrix} x_1 = 32 \\ a_1 = 31 \end{matrix}\right\} \left.\begin{matrix} x_2 = 12 \\ a_2 = 9 \end{matrix}\right\}$$

Where the x's refer to the husbands and the a's to their wives, but where each set is not, as yet, assigned to the proper couple. But one of the men, Hans, buys 23 more pigs than one of the women, Susan, and Peter buys 11 more pigs than Gretchen. By inspection, then, Hans and Susan must be represented by x_1 and a_8, Peter and Gretchen by x_2 and a_2 leaving x and a_1 to represent Jason and Lisa. Assorting the couples, then, as shown in the bracketed equations above, the matrimonial tangle, together with individual purchases of pigs, is resolved into

Peter	12	Hans	32	Jason	8
Susan	9	Lisa	31	Gretchen	1

—ED. ENG. NEWS.]

Pumping Station Costs, Philadelphia Water Works

Sir—In your issue of Aug. 12, 1909, I presented a communication, with a table and diagrams, showing what appeared to be not only an excessive pumping-station cost on the part of the Philadelphia water works during the preceding eleven years, but a startling increase (nearly 100%), in that cost during those eleven years. I quote as follows from the communication in question:

> I had occasion to study the relation between the size of a pumping plant and the cost of operation per unit of work done; and, for this purpose, I plotted a large number of data, from which it appears (1) that the cost, per unit of work done, is, as might be expected, very high in very small plants; (2) that it drops very rapidly as the size of these small plants increases, and (3) that, at a very moderate size of plant, the curve turns abruptly and becomes nearly horizontal, further increase in size of plant producing relatively little diminution in cost of operation.
>
> Now, Philadelphia having probably the largest municipal pumping plant in the world, I was naturally curious to see how it stood in relation to this curve. To my surprise, I found that the cost, in 1898 (when I was in nominal charge of the Bureau of Water) was about double what it should have been according to this study; but I was still more surprised when I came to plot the cost for 1907, the date of the latest annual report, and found that the cost then was nearly double that of 1898, or about four times what it should have been; notwithstanding that, in the meantime, the pumpage had materially increased (a change which should have slightly diminished the cost per unit of work), and notwithstanding that the proportion of antiquated and low-duty pumps in the system had very greatly diminished.

Inspection of the Annual Report for 1910 (the latest issue) shows a material improvement, and I am glad to submit revised diagrams showing this. [We reproduce Mr. Trautwine's original table, with the 1910 figures added, but not his diagram—ED.]

It would appear, however, that the cost in 1910 was still more than double what

COST OF STEAM PUMPAGE (PUMP-HOUSE EXPENSES) AT PHILADELPHIA
1894–1907, AND 1910
(From Annual Reports of the Bureau of Water)

	Billions of gal. 100 ft.	Fuel cost: for year	Fuel cost: per mil. gal. 100 ft.	Pay of employees: for year	Pay of employees: per mil. gal. 100 ft.	Total: for year	Total: per mil. gal. 100 ft.
1894	121.2	$226,700	$1.87	$118,500	$0.98	$422,252	$3.48
1895	132.0	274,311	2.08	131,612	1.00	487,765	3.69
1896	161.8	322,226	2.00	148,856	0.92	556,304	3.43
1897	187.4	349,320	1.86	158,154	0.84	591,480	3.16
1898	201.8	373,199	1.77	177,630	0.84	625,159	2.97
1899	231.8	410,789	1.77	185,199	0.80	672,526	2.90
1900	218.1	460,677	2.11	231,617	1.06	810,078	3.71
1901	227.7	465,691	2.04	297,907	1.31	871,886	4.14
1902	239.7	611,519	2.55	390,700	1.63	1,152,229	4.80
1903	248.8	744,563	2.99	381,715	1.54	1,292,456	5.20
1904	251.2	733,697	2.93	375,941	1.49	1,284,004	5.11
1905	261.3	665,742	2.55	383,747	1.47	1,204,628	4.61
1906	257.3	647,808	2.52	404,758	1.57	1,302,240	5.06
1907	242.3	625,403	2.57	442,089	1.82	1,376,123	5.68
1910	284.2	618,381	2.17	477,744	1.67	1,196,243	4.20

it ought to be, judging from the curve derived by plotting the pump-house expenses of other and smaller works.

At that time, however, the administration was still under the same so called "political" control, as in 1907. Under the present unquestionably upright administration, Chief Dunlap will doubtless have opportunity to show what he can do in the way of bringing these figures still more nearly to what they ought to be.

JOHN C. TRAUTWINE, JR.

Re-Rolled Rails for Concrete Reinforcement

Sir—I must confess that I am somewhat surprised that some of your correspondents have asked for more detailed information as to why re-rolled rails should not be used for making bars for reinforced-concrete construction (ENG. NEWS, Feb. 29, 1912, p. 406). I assumed, in view of the almost daily reports in the press and newspapers of the breaking of rails causing wrecks and loss of life, that one would be forced to believe that it was unreliable material to use, without further argument. However, I will give my reasons as requested by your correspondents.

It will be conceded, I think, that the essential requirements for steel for reinforced-concrete construction should be as follows:

(1) It should be uniform in quality.

(2) It should be tough and ductile, so that it can be bent and twisted without injury, both hot and cold, and after being heated and allowed to cool.

(3) Its process of manufacture should be such that tests could readily be made on it without too much difficulty, and the records of materials thus tested not lost track of, and that these tests would be a reliable assurance of the material purchased being in accordance with the tests.

Now material rolled from old rails meets none of these requirements, inasmuch as it is, (1) not uniform; (2) not ductile and tough so as to be able to be bent and twisted, both hot and cold without injury; (3) a very difficult material to properly sample because of its great lack of uniformity.

My claims are based upon abundant evidence.

First, as to lack of uniformity. Rails made today differ very much in quality from what they were a few years ago, the specifications under which they have been rolled and the requirements of the various railroads varying materially from time to time.

In January last, President James A. Farrell, of the United States Steel Corporation, testified before the Stanley Committee as follows:

> Most of the rails used in this country are of an inferior grade, because the roads place economy before safety. The carbon is so high that we get the brittle rail. It is true that many of the hard rails never break, but the liability to breakage is much greater than in the old time softer rail, and the influence of the unavoidable contingencies of manufacture, such as seams, pipes and segregation, is much greater. In many respects the steel is more doubtful, more dangerous and more treacherous. It is unquestionably in my judgment, an unsafe grade of steel, in view of the severe conditions of service.

Mr. Nichols, Vice-President of the Great Northern Railway, replied to this as follows:

> All the roads have found for the past two or three years that the quality of rails has been deteriorating. We have found this year that 68-lb. rails laid down 12 or 13 years ago purchased from Germany, are giving better service than 90-lb. rails laid down two or three years ago, made in this country, and this under exactly the same conditions of traffic.

Page after page of evidence can be cited to prove that rails today are not what they should be, and oftentimes are brittle and unreliable. It is enough to say that the Interstate Commerce Commission's report states that in the ten years ending June 30, 1911, there have been accidents due to the breakage of rails causing the loss of *over* 100 *lives* and injury to *over* 4000 *persons*. A very large percentage of all the casualties—about *one-fourth of the deaths and about one-third of the injuries—due to defects in roadbeds in railroads, can be charged against the breaking of rails.*

Now as to the tests and specifications which are commonly adopted for the manufacture of steel rails. No bending test is required. Only chemical requirements and a drop test are specified. The carbon permissible is from two to three times that allowed in any kind of steel recommended by any authority for use for structural purposes, and the phosphorus and sulphur are much higher than what is considered proper today for steel to be used for such purposes. High-carbon steel, it is, of course, well known, is much more liable to be injured by heating than low-carbon steel, and must be much more carefully worked and handled. The phosphorus and sulphur permissible in steel rails is so high that the material rolled from it often cracks in bending, whether bending is done hot or cold.

Another serious matter in connection with the high-carbon, high-phosphorus and high-sulphur steel rail is its liability to have pipes, seams and segregation. Now does the mere re-rolling of rails into bars remove these defects, or does it only distribute them over more lineal feet?

Regarding the difficulty and expense of the inspecting and testing of this kind of material. As a single consignment of rails might include ever so many various makes, it would be extremely difficult to obtain any useful and reliable record of the heat numbers under which they were rolled, and therefore, to know whether originally, they were rails accepted after competent inspection, or rejected rails, or seconds. Inasmuch as there might easily be a wide variation in the quality in the rails of a single consignment, how would the purchaser be at all assured of what he was getting, unless he had a specimen tested from every rail?

I have been informed by reputable reinforced-concrete constructors that they have found it unreliable and dangerous, bars breaking in bending and twisting.

As human lives depend upon the safety of our structures, there is no reason in my opinion why steel to be used for reinforced concrete should not meet the same rigid tests as are considered essential to the use of steel for structural purposes, and which have been based upon so many years of experience.

EUGENE W. STERN,
Consulting Engineer.
Park Ave. and 41st St., New York City,
Apr. 6, 1912.

Quiescent and Impact Loads on Reinforced-Concrete Slabs

Sir—In ENGINEERING NEWS, Mar. 21, 1912, p. 564, there appeared an abstract of a paper by Naoji Shiraishi, a Japanese engineer, published in the *Proceedings* of the Institute of Civil Engineers, session of 1910-1911. The paper is descriptive of a concrete warehouse in Kobe, Japan, and the structure is worthy of note because it is one of the first reinforced-concrete buildings erected in that country. Attention was called to the tests made on concrete floor slabs, in connection with the work referred to, by Mr. Shiraishi, who was the engineer in charge. The author's deductions from these tests are at variance with the facts given and the writer hopes that a discussion of this point will prove of interest to engineers in general.

To assure himself that he had all the data the writer referred to the paper as published complete in the *Proceedings* and his quotations and data are from the original. To use the language of the author he "prepared a few experimental slabs with different kinds of expanded metal and different kinds of Japanese cement, and again slabs with wire reinforcement." Later referring to the impact tests subsequently made, he states that they were disappointing "no matter what the specimen of cement used, nor what the type or amount of reinforcement used." The writer regrets that the former quotation does not tally with that published in ENGINEERING NEWS, which omits the reference to tests on slabs with wire reinforcement, as the deductions would imply that expanded-metal reinforcement only had proved disappointing in this respect.

The concrete test slabs were 4 in. thick and of a clear span of 4 ft. 6 in. The warehouse was to be used for stor-

ing bales of cotton, bags of rice, flour and beans. The floor was designed for a quiescent live load of 350 lb. per sq.ft. Two kinds of tests were made: (1) with quiescent or static loads uniformly distributed; (2) with dynamic loads secured by dropping a bale of cotton weighing 600 lb. from various heights ranging from 2 ft. to 6 ft. These impact loads were regarded by the author of the paper as not unlikely to occur in practice, although the floor was actually designed for the quiescent live load as stated above. The results of the tests were what might have been expected from properly constructed slabs of this type. The quiescent load tests, in the language of the author, "were considered very satisfactory, the testing staff proudly pointing out to visitors the enormous strength of the slabs." Regarding the impact tests the author states they "told a very different tale * * *. It was very disappointing to find that slight cracks began to appear from the drop of only 3 ft. * * * With a drop of 6 ft., failure was complete in every case. Such resistance to impact was considerably less than expected, and the results of the tests were to give a sharp warning that heavy articles should be handled with great caution on floor slabs."

In the opinion of the writer, however, this conclusion is at variance with the facts, as can be easily shown. Under ordinary circumstances it is not easy to compute the quiescent load corresponding to an impact load caused by the fall of a given weight from a known height. Prof. Merriman in his "Mechanics of Materials," edition of 1905, pp. 329 to 330, gives the following formulas as the basis for this computation:

$$\tfrac{1}{2}Qq = P(h + q)$$

$$q = f + f\left(1 + \frac{2h}{f}\right)^{\frac{1}{2}}$$

where

P = Weight of the dynamic or dropped load;

q = Deflection caused by the dynamic load P;

f = Deflection caused by a static or quiescent load equal to the weight P;

Q = Static load which will produce the dynamic deflection q.

Usually it is very difficult to compute the deflection f which is necessary to the solution of the problem. Mr. Shiraishi gives in his complete paper a table of deflections measured under various static loads on slabs similar to those tested for impact. This table of deflections greatly simplifies the computations in this case. By slight interpolation of the values given, the writer found that a static load of 600 lb. per sq.ft. had produced a deflection of 0.03 in., and that this was very close to the theoretical deflection as computed by the author. Substituting the known values in the formulas above given, the quiescent or static load corresponding to the dynamic load P dropped from a height of 6 ft. is 42,000 lb. Is it to be wondered that the 4-in. slabs failed completely in every case? The astonishing feature of it is that these slabs actually sustained this load at a drop of 3 ft. While the results deduced by this formula can only be considered as an approximation it will not be denied that it is sufficient to show that the slabs were enormously over-stressed.

The writer is forced to believe that these slabs showed remarkable strength in this respect, and the results could be called anything but disappointing. It is to be regretted that the slabs were not designed for the dynamic load in the first place instead of the uniform quiescent live load actually used. It is not always possible to design buildings for impact loads, but wherever possible this method should be followed. For this reason the writer has always argued against the use of light live loads in the design of any building, even though the architect is sure that the floors "will never be fully loaded." The fact still stands that the dropping of a small load on a floor will produce far greater stresses than will ever be encountered from quiescent loads, and might easily cause the failure of the floor.

A. V. SPINOSA, Directing Engineer,
The Consolidated Expanded Metal Cos.
Pittsburg, Penn., Apr. 10, 1912.

Concrete vs. Stone Masonry Sea Walls

Sir—My attention has been called to the concrete and sheet-steel sea walls recommended by Myron H. Lewis in an article in ENGINEERING NEWS, Jan. 4, 1912, p. 10.

The article is interesting as suggesting new ideas in this line of construction, but to one who has had to do with sea walls, revetments, etc., both the schemes seem rather academic, indeed too much so for practical purposes. Experiments are always good when by their success a cheaper or more secure structure is obtained. However, the experiments mentioned in the above article are nearly as expensive as the older methods that have been used enough to prove their worth.

Referring to the L-shaped reinforced-concrete retaining wall described in the above mentioned article (Fig. 1 herewith), the exact elevation of the bottom of the wall is not given, but it is assumed to be approximately at mean low water from the drawing. A peculiar action of storms along sea walls and bulkheads is to transplace, from time to time, the beach material, removing it to a depth of 5 or 6 ft. in some places and filling in others to as great a depth. Should a condition of this kind take place along the concrete wall it would be entirely undermined and failure would of necessity follow. We do not insist that this particular wall will fail because of the above defect, but on the other hand if we were to build a number of walls in different localities, 50% of them would fail because of this fact within a period of ten years.

As a second condition, suppose an abnormally high tide is produced by the combination of ordinary conditions and a heavy storm, such as frequents our coast. For instance the New Year's storm of 1909, when the tides along the Atlantic Coast exceeded normal tides from 6 to 12 ft. Such a tide as explained would flood the material back of the wall by percolation, and in passing out would carry some of the back fill down under and out between the bearing piles. A repeated difference of head between the water back of the wall and in front would seriously undermine the structure, leaving the bearing piles to hold the wall alone. Assume

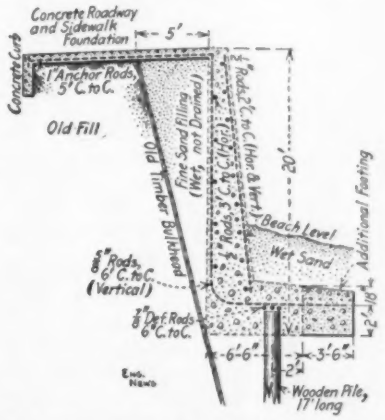


FIG. 1. ORIGINAL AND FINAL SECTIONS OF A REINFORCED-CONCRETE SEA-WALL

(Reproduced from Engineering News, Jan. 4, 1912, p. 10.)

that this action has taken place in a very small degree, then the whole wall stands on the pile as a pivot and any masonry in front of the pile will add to the strains in the wall, either breaking the footing immediately over the pile, or tending to break the wall at the junction of the footing and wall or at the junction of the top with the tie slab. As the transverse footing reinforcement is not raised up over the pile top to guard against cantilever action of this kind, it is probable that the footing would break off directly over the pile, resulting in certain failure of the wall.

Suppose the wall has been unusually fortunate and escaped the possibility of being undermined, and that the material it is built on is unusually good and practically impervious. These conditions, therefore, obviate the possibility of failure as explained above; there are then other weaknesses to be considered. The possibility of the walls resisting back

pressure depends upon the steel in the face, probably between 2 and 4 in. from the face. If the face of the wall is not protected by some covering that forms an absolute barrier to the entrance of salt water or sprays, the surface will have cleaved off or softened in three years to the depth of 3 in., and the steel reinforcement will be subjected to the action of the salt air which will make rapid deterioration sure. If the wall is thoroughly waterproofed by the integral method, its possibilities of resisting the action of the sea water will be about doubled. That is, we could assume six years as the life of the protective coating, perhaps four years more before the steel would be destroyed, after which time the life of the wall would be a matter of chance. The temperature changes are as great in a sea wall as about any structure that concrete is used in, owing to periodical immersions in the spray or water of the surf. If the wall is not divided into sections to allow for shrinkage and expansion, cracks will occur. In either case water will find access to the steel reinforcement and deterioration will result. The action of sea water on concrete, causing it to rapidly deteriorate, is very widely published and known. With all these objections to the reinforced-concrete wall, there is also the fact that the wall is nearly as expensive as a permanent structure, would in fact be fully as expensive when a proper foundation is put under it.

The steel sheet-piling sea wall would be unquestionably better than the reinforced-concrete wall. There is, however, the question of coating this wall so as to protect it from the action of the weather. In the first case if the piling is coated with a cement for protection, there will be the action of the sea water as in the case with the concrete wall. We have not been able to yet put a plaster coat on a hard irregular surface and not have expansion cracks occur in the coating at least five times out of ten. The position and condition of the piling make the application of a coating very difficult, and because of this fact decrease the probability of a thorough job. It is simple enough to specify that the sheet piling shall be covered with carefully stretched metal lath and this thoroughly filled with a waterproof cement coating. It is altogether different to instruct a laborer to go down into a trench 2 or 3 ft. wide, with 2 ft. of mud and water in it, and apply the coating so it will satisfy the requirements of the specifications. The rods that anchor the steel piling to the back fill would rust out in 15 years, at least, and probably the coating would not last this length of time.

The sketches, Figs. 2-3, were drawn to show the amount of material per lineal foot of wall built much as they were before the use of reinforced concrete became so popular. If the tops of the wood sheet piling are cut off at or near the low-water line, there will not be deterioration due to the teredo or ordinary decay which would soon attack the wood between mean low and high water. For a beach of sand or light soil, the sheet piling is absolutely necessary and in any case it is worth while. When driven from 7 to 10 ft. the piling will hold a wall to 20 ft. in height. In cases where the soil is very soft, bearing piles and concrete

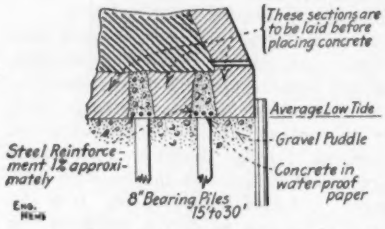

These sections are to be laid before placing concrete
Average Low Tide
Gravel Puddle
Steel Reinforcement 1% approximately
Concrete in water proof paper
8" Bearing Piles 15' to 30'
End Head

FIG. 2. TYPICAL MASONRY SEA-WALL ON ORDINARY GROUND

would be necessary as shown in Fig. 2.

In the construction of sea walls it is possible to get a rubble stone weighing up to 1000 lb., landed from the water at high tide, from a light-draft barge where necessary, at prices much less than this grade of stone can be gotten by hauling with teams or otherwise. Along the coast of New England and the Central States, the price would range between $1 and $2.50 per cu.yd. These stone can be pitched off and laid so as to give thin mortar joints at the face and rendering a good appearance as well as a practically indestructible surface exposed to the action of the water. There is a fair profit in placing these stone in a wall at $6 per cu.yd., making the total cost of the masonry less than $8 per cu.yd. complete. Concrete might be put in slightly

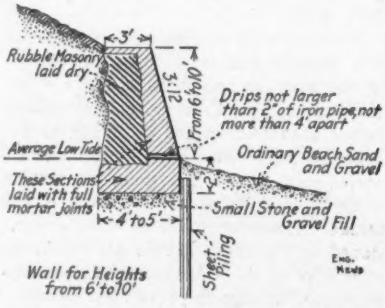

3'
Rubble Masonry laid dry
3:12
From 6' to 10'
Drips not larger than 2" of iron pipe, not more than 4' apart
Average Low Tide
Ordinary Beach Sand and Gravel
These Sections laid with full mortar Joints
4' to 5'
Small Stone and Gravel Fill
Sheet Piling
Wall for Heights from 6' to 10'
End Head

FIG. 3. MASONRY SEA-WALL ON PILES AND CONCRETE BEAMS

cheaper per cubic yard, perhaps 15%. This small difference is but an insignificant argument when nearly every concrete structure exposed to the sea water is an object lesson of its inadaptability for the purpose.

The estimate for a wall per lineal foot in length and 10 ft. in height, all as shown in Fig. 1, assuming that the sheet piling should be 10 ft. long, will run about as follows in most localities:

Sheet piling L. L. pine, grade merchantable, all in place	$11.35
Gravel or broken stone to be put under wall	0.15
Mortar-filled rubble masonry	0.15
Dry rubble masonry	0.15
Pipe drains 2 in. galvanized w. i.	0.62
	0.15
Total	$12.02

The same type of wall 20 ft. high and built on fill with concrete supports as shown in Fig. 3, will be about $32.75 in most localities.

The matter of proportioning the concrete girders to support in part the weight of the masonry is most easily decided by assuming that ½ or ¾ of the weight of the wall will be supported by the earth, as the case may be. The piles should be driven until they bear a 10-ft. stroke of a 1000-lb. hammer, with a penetration of not more than 1½ in. If it is not possible to drive the piles to this bearing, one of the formulas that have been developed from experiment can be used, and the piles so placed that the size of the girders will be kept within reasonable limits. The stone that are laid between the girders or on the sides need not show a uniform surface, but can be laid in so as to accommodate the size of the stone. A layer of waterproof paper or tarred felt should be carried along ahead of the work, placed directly on the clay and gravel foundation under the wall. This will tend to prevent percolation of water into the masonry before the cement has set up.

G. L. BILDERBECK,
Civil Engr. and Supt. of Construction, U. S. War Dept.
New London, Conn.,
Mar. 21, 1912.

Notes and Queries

Erratum—In the letter on the "breathing" of water falling over a dam, in our issue of Mar. 28, 1912, p. 601, Mr. J. F. Jackson was erroneously given as Vice-President of the Milwaukee Bridge & Iron Co., instead of the Wisconsin Bridge & Iron Co. The mistake was made in writing the name of the firm under the signature of the original letter.

The Short Ballot Organization of New York City, to which we were largely indebted for the list of commission-government cities, published in our issue of Apr. 4, 1912, informs us that at a second election, Irvington, N. J., reversed its former vote and decided against the plan; also that neither Sherman nor Terrell, Tex., should be classed as commission cities. It should be noted, however, that there is a difference of opinion as to just what does or does not bring a city into the commission class. We listed Sherman on the authority of the National Municipal League and Terrell on the authority of Bradford's recent book on commission government. It is only fair to add that the Short Ballot Organization takes special pains to check all reports that cities have adopted the commission plan. At frequent intervals the "Short Ballot Bulletin" contains a revised list of commission cities.

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Engineering News

A Square Deal in Letting Philadelphia City Contracts

The political contractors who have so long run Philadelphia's city government for their own profit (and were never stingy about the profit, either), have struck hard times. There is nothing doing on the old lines in the huge old city hall crowned by William Penn's statue.

All those nicely planned artifices by which, under the old régime, a public contract was transformed into a private snap, are wholly unappreciated by the new city administration. Under the old plan of contract letting, it was so very easy, by little jokers in the specification or other devious ways, to serve notice on an outside contractor that if he knew what was good for himself he had better stay outside. But these new fellows in the city hall actually insist that the outside contractor shall have a square deal.

And not only is the outlook for future big rake-offs very bad, but the courts are so unkind as to compel the giving up of some of the spoil accumulated in past forays.

Recently a Supreme Court Judge upheld a lower court decision in a taxpayer's suit brought in 1910, that a paving contractor must restore to the city some $54,000 of payments on asphalt-repair work. This money had been obtained by the old unbalanced bid trick: in this case, 20c. per sq.yd. was bid where repairs exceeded 500 sq.yd. in a single block and 75c. for repaired areas of 100 to 500 yd. The notice to bidders indicated that 72½% of the repair work would be in areas exceeding 500 sq.yd., but when the final estimates were made up this percentage had somehow fallen to 17.2%.

Another favorite Philadelphia trick has also been scotched by the same court: that is, the supplementary contract, by means of which a contractor who had a $50,000 job was assigned additional work from time to time at the same prices as prevailed under the original contract until his total receipts ran into the hundreds of thousands.

These are only samples of the methods by which favored contractors have grown rich and "outside" contractors have been warned away from the gang's private preserves under the penalty of being "trimmed."

If the new administration can restore the confidence of outside contractors and give Philadelphia real competitive bidding on public contracts, immense sums may be saved to the taxpayers.

There are grounds for hope that the classic comment on Philadelphia, "corrupt but contented," may yet become obsolete.

Filtering Water to Waste It at Philadelphia

When Philadelphia, against the advice of a number of the most eminent consulting engineers of the country, started to build water-filtration works twice or more as large as would have been needed had proper steps been taken to cut down water waste, it was urged in justification that by building the filters of that size at the outset and then gradually reducing water waste, the filters would suffice for a generation to come.

For the interest of the favored contractors and the Philadelphia politicians (which for many years were one and the same in Philadelphia) this reasoning was sound, for it meant extravagant prices for building works twice as large as were required to furnish the water needed for actual use. Thus between needless size and the excessive prices due to the stifling of competition and political favoritism, Philadelphia had to pay out three or four times as much for its filtration works as would have been required under honest efficient municipal government.

Bad as this was, it is not the worst. No steps were taken to curtail water waste. On the contrary, even an ordinance which permitted meters to be installed at private expense was repealed by the City Councils a few years ago.

As a result of all this and other chicanery the immense filtration works of Philadelphia are already inadequate to meet the demands upon them. The average water consumption and waste per capita in 1910 was 203 gal., or from 50 to 100% in excess of what it need be.

The successive chiefs of the water bureau, including the present chief, Fred C. Dunlap, of Philadelphia, have consistently and persistently urged that water waste be cut down. There is reason to believe that now, under a reform mayor and with a director of public works who for years past has been preaching and practicing the modern doctrines of scientific management, the officials of the city government will make a determined effort to cut down water waste, as well as to increase the efficiency and lower the cost of the whole water-works service.

We understand that steps have already been taken to repeal the ordinance prohibiting the use of water meters in Philadelphia. That is only a tiny beginning of what needs to be done, as those now in administrative control well know.

Whether more can be accomplished through Councils is uncertain, but doubtless the executive department will at least be able to demonstrate by water-waste surveys what enormous quantities of water are wasted in Philadelphia, with benefit to no one and with injury to all.

The most serious injury is that to health. This comes in a twofold manner: (1) The character of the water supply is endangered by the overdrafts on the capacity of the purification works and the necessity of supplying unpurified water at times; (2) the money thrown away to pump and purify water which is wasted, and to pay capital charges on works required only to provide water to waste, is badly needed for other health-protective work.

The whole country will await with interest the outcome at Philadelphia. Is the city capable of rising to real and permanent reform? No director of public works has before had quite the opportunity presented to Morris L. Cooke—and none has had to contend with greater odds. If he fails, it will be largely through lack of public support.

Governor Woodrow Wilson's Veto of a Pernicious New Jersey Sewage Disposal Bill

A bill passed by the New Jersey legislature, designed to frustrate the sewage-disposal plans of Orange, East Orange and Montclair, N. J., was recently vetoed by Governor Woodrow Wilson. The veto was accompanied by a message which sets forth some fundamental principles in sanitation, municipal coöperation and state administrative control of local matters well worth a wider publicity.

The occasion for the veto was this: To escape from an inequitable distribution of the cost of the Passaic Valley trunk sewer which would have been imposed upon the three cities named had they joined the Passaic Valley Sewerage District (see editorial discussion in our issue of Feb. 23, 1911) these cities proposed to unite in building Imhoff tanks and sprinkling filters on a site located in the adjacent towns of Bloomfield and Belleville. Land had been acquired for the purpose and preparations for construction were under way, when the two municipalities just named succeeded in getting a bill through the legislature prohibiting any city or town from building sewage-disposal works in another municipality without first having obtained the consent of the authorities of such other municipality.

Had the bill been designed to establish permanently a state-wide policy it would have been questionable enough, for the reasons ably stated below by Governor Wilson; but it was openly avowed to be aimed against the three municipalities named, and to be subject to repeal when it had served this special purpose. (A similar bill passed a dozen years or more ago, and aimed against South Orange, was afterward repealed, or else has been forgotten.) Moreover, it was backed by those who wished to see Orange, East Orange and Montclair forced into the Passaic trunk-sewer scheme or else severely punished for having staid out.

We print Governor Wilson's reasons for his veto because the principles stated apply with equal force to all densely populated states:

> A very careful consideration of this bill convinces me that it is based upon a most unsafe and unscientific principle.
>
> The question of sewage affects whole sections of the state. It cannot be dealt with community by community, without regard to the topography of the country, the method and closeness of its settlement or the natural facilities for disposing of sewage.
>
> Political divisions are in no sense natural divisions when this most difficult matter is to be handled. To adopt the principle of this bill would be to embarrass engineering undertakings connected with the public health in the most serious way, and in some instances might render them impossible.
>
> Any careful consideration of the great urban areas of the northern part of the state will convince a careful student of this subject that those areas must be studied as wholes and dealt with as wholes, and that it is not safe to put the settlement of neighborhood questions with regard to drainage in the hands of any authorities having a smaller jurisdiction than that of the state itself.
>
> It would seem that the present powers of the State Board of Health are sufficient to safeguard the several political divisions of the state against the deleterious influences resulting from sewage disposal within their limits, and if the board has not now powers sufficiently comprehensive to accomplish this object, such powers should certainly be conferred upon it, rather than allow questions of drainage to be settled by neighborhood preferences and jealousies, instead of by the scientific rules of sanitary engineering.
>
> I think the establishment of the principle involved in this bill would be a most unsafe experiment.

Governor Wilson might have added that a logical application of the principles underlying the bill would prevent the discharge of sewage through the Passaic Valley trunk sewer into New York Bay, without the consent of New York State on the one hand, while on the other it would prevent the location of the sewage-disposal works of a single city in any district of the city without consent of the residents in its neighborhood. The ultimate effect of the last principle might be to compel householders to return to cesspools or privies.

In conclusion we would urge, as we have repeatedly done in the past, that the questions involved in such local controversies as this are not fit subjects for legislative interference, but should be delegated by the legislature to a state administrative body, selected for just such work, and provided with a competent technical staff. Jurisdiction over local sewage-disposal works in New Jersey is already vested in the State Board of Health. If its powers are insufficient then, as Governor Wilson suggests, they should be increased.

Archaic Methods of Railroading on the Illinois Central

The official report just issued of the Interstate Commerce Commission's Inspector concerning the Kinmundy rear collision on the Illinois Central R.R., which occurred on Jan. 22 last, gives substantially the same facts regarding the conditions which brought about the collision as were reported at the time in ENGINEERING NEWS. There are additional facts given in the report, however, as to the volume of traffic on this division of the Illinois Central R.R. and the method of operating trains thereon, which deserve a much wider publicity. The report states that there are no block signals whatever on this division of the main line of the Illinois Central R.R., extending from Champaign to Centralia, 125 miles. There are 23 stations on this division, at which train orders can be received and delivered. Only two of these stations have telegraph operators always on duty. Five other stations have night operators only and at the remaining 16 stations operators are only on duty in the daytime. Train rules in force permit trains to follow each other over the division without restriction, except at such telegraph offices as are open, where trains running in the same direction are required to be spaced 10 minutes apart. Inspector Belnap, of the Commission, says:

> This system of operation affords protection in the immediate vicinity of open telegraph offices, but on account of the long distances existing at night between open offices, a fast train can overtake a train moving at a slower rate of speed.

This, however, only begins to state the inherent danger in this vicious old system of railway operation. There are a hundred causes which may stop a train when it is barely out of sight of a telegraph station; and if the stop is of more than 10 minutes' duration, the only protection whatever which this train has against a following train running at full speed into its rear is the back flagman.

We have said that this division on which the collision occurred is the main north and south line of the Illinois Central R.R. Inspector Belnap states that during the year 1911 the average daily traffic over this division was about 23 trains in each direction, or nearly a train

every hour. There are seven scheduled passenger trains daily in each direction over this division. These trains are run on as rapid schedules as if the road were equipped with a space-interval system of operation. We have before us the schedule of one of these trains, which calls for a running time between Champaign and Centralia of 2 hours and 41 minutes, or an average speed, including time spent in stops, of 48 miles per hour. There are five station stops scheduled for this train in this run of 125 miles, and allowing for the necessary variations of speed on grades, etc., it is evident that a good part of the run must be made at 60 miles an hour, or better, to maintain the schedule.

In the equipment of its passenger trains, apparently, the Illinois Central does not stint expenditures. Most of its fast express trains are electric lighted and the trains bear such names indicative of speed as Fast Mail, New Orleans Special, Panama Limited, Dixie Flyer, Diamond Special. If the railroad can afford this lavish expenditure on fast through trains, then it certainly can afford the expenditure necessary to give the travelers by these trains such reasonable protection against death by collision as good railway practice has dictated for more than a quarter of a century past.

And the company does not lack the money to make necessary improvements. The net earnings of the Illinois Central for the past 10 years have varied from $13,500,000 in 1900-01 to over $22,000,000 in 1906-07. The average dividend disbursements since 1902 have averaged nearly $6,750,000 per annum. The company, cannot, therefore, plead poverty as excuse for its long-continued failure to adopt the block system for protecting its trains on its lines of heavy traffic. The plea of poverty would not avail anyway, for under such traffic conditions as exist on the Illinois Central, the investment in a block-signal system and the cost of its operation would be fully repaid by the reduction in accidents and damage expenses.

Inspector Belnap's report states that the installation of 17.26 miles of automatic block signals at different points on this division has been authorized and the signals will soon be in operation. This will give protection on about one-seventh of the length of this division. This is good as far as it goes; but it falls far short of recognizing past folly in continuing obsolete methods, long since abandoned by progressive railways the world over.

We do not know whether the conditions of this main-line division of the Illinois Central as respects lack of safe train-operating conditions are typical of the conditions of other parts of the system, nor do we know where the responsibility lies that the Illinois Central is so far behind well managed railways in adopting safe methods of train operation. It is well established, however, that final responsibility for railway operating conditions rests with the Board of Directors. *Punch* long ago proposed to prevent collisions by tying a director on the front of the locomotive. If such a remedy were effective, then the number of railway presidents and prominent railway officials in the United States, who have been killed in rear collisions which might have been prevented by even an elementary form of the block-signal system (the list including ex-President Harahan, of the Illinois Central, in the Kinmundy accident, and President Samuel Spencer, of the Southern R.R., in a rear collision on his own road a few years ago) ought to have long ago convinced American railway managers of the folly of adhering longer to the obsolete train-order system.

It may be, however, that it is not the operating or executive officials who are at fault in this case, but the Board of Directors. In any event these men are responsible if the company they control fails to adopt a proper policy with reference to the installation of safety appliances. It is worth while, therefore, to put on record the fact that among the directors of the Illinois Central R.R. are J. Ogden Armour, Chicago; John Jacob Astor, New York; Henry W. DeForest, New York; Robert W. Goelet, New York; Robert F. Lovett, New York; Charles A. Peabody, New York, and Cornelius Vanderbilt, New York.

European and American Water Supplies and Typhoid Death Rates

Some years ago an excess of 20 typhoid deaths per 100,000 population was commonly regarded as proof positive of a contaminated public water supply. Studies at Washington, D. C., and Richmond, Va., and a fuller and more exact knowledge of the general subject have led to the conclusion that a high typhoid rate does not necessarily mean an impure water supply. Other capacious vehicles of infection exist, particularly in the southern part of the United States, and probably under high temperatures generally.

The foregoing remarks have been prompted by a recent paper by Dr. Allen J. McLaughlin,* in which he compares the typhoid death rates of the leading cities of northern Europe and of the whole United States, in the course of a discussion of water supplies and typhoid fever.† By implication and more or less direct statement the large excess of the average European typhoid rates over the average American rates for the cities listed is attributed to the relatively inferior character of American water supplies.

While Dr. McLaughlin's statistics (Tables I to III) are valuable and while his argument for pure water supplies is forcible and on the whole eminently sound, yet we think he ought to have carried his statistical studies further or else qualified his apparent conclusion that the lower European typhoid rates are chiefly due to the superior quality of the European water supplies.

Coming now to the specific figures, we find (Tables I and II) that 33 of the leading cities of Europe had an average typhoid death rate of 6.5 per 100,000 in 1910, as compared (Table III) with a rate of 25 for 47 American cities. But the European cities were all in northern Europe, while the American cities were distributed through the southern as well as the northern portion of the United States.

It is well known that typhoid rates are high in many of our southern cities, and if we mistake not the same is true for the cities of southern Europe. From this point of view Dr. McLaughlin should have included southern Europe, in order to make a true comparison between the two continents. Moreover, if Dr. McLaughlin is right in assuming that the typhoid rates of the smaller American cities are higher than those of our larger cities, then it would have been well if he had taken cities down to 100,000 population in his European list, as he did in his American. Still another criticism that may be made of Dr. McLaughlin's figures is that with the exception of the ten largest European cities only the years 1909 and 1910 are covered.

Some inferences as to the importance of the points raised in the preceding paragraph may be drawn from an article by G. R. Taylor, published in our issue of Apr. 21, 1910 (pp. 451-4).* Statistics for some four hundred cities of 8000 population and upwards, many of them for the eleven years 1898-1908, showed no southern city with an average typhoid rate of less than 30 per 100,000. The distribution of cities by typhoid groups seemed to show that, excluding certain extremes, the sizes of the cities had very little to do with high or low typhoid rates. The chief exceptions were that all the average rates below ten were in cities (fifteen in number) of less than

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†"The Necessity for Safe Water Supplies in the Control of Typhoid Fever." A paper read before the Illinois Water Supply Association, Mar. 5, 1912. The paper appeared in "Public Health Reports" (Washington, D. C.) for Mar. 22, 1912, and will doubtless be published in the "Proceedings" of the Association.

*A Classification and Studies of the Typhoid Statistics of the United States." By George Rodney Taylor, Chemist and Bacteriologist of the Scranton (Penn.) Gas & Water Co. The cities were arranged by increasing average typhoid death rates. Besides period averages, the maximum and minimum yearly figures were given. Summaries were presented for all the registration states and also comparative summaries for the registration cities of the North and the South.

TABLE I. TYPHOID DEATHS PER 100,000 POPULATION FOR TEN LARGE CITIES OF NORTHERN EUROPE

	Averages '01–'10	'01–'05	'06	'07	'08	'09	'10
Stockholm	1.7	3	2	2	1	5	1.8
Christiana	2.4	3	4	2	2	1.7	1.6
Munich	2.5	4	2	3	3	1.9	1.4
Edinburgh	2.9	8	3	3	2	1.2	1.3
Vienna	3.7	4	5	3	4	2.8	3.8
Hamburg	3.7	4	4	3	4	3.3	4.1
Berlin	3.8	4	4	4	4	4.2	2.9
Dresden	4.2	4	7	2	6	4.2	2.2
Copenhagen	4.5	8	4	2	7	2.7	3.6
London	4.7	8	6	4	5	2.2	3.3
Averages, 1909 and 1910 only						3.4	2.5

Total population of the 10 cities, about 15,000,000

TABLE II. TYPHOID DEATHS PER 100,000 OF TWO GROUPS OF NORTHERN EUROPEAN CITIES

City	1909	1910
Group I:		
Frankfort	1.5	0.9
Antwerp	1.0	2.3
Bristol	2.8	2.1
Nuremburg	2.6	
Birmingham	5.0	3.9
Belfast	5.2	3.9
Lyons	5.8	4.4
Leeds	7.2	3.8
Liverpool	8.4	3.9
Sheffield	9.4	3.0
Rotterdam	6.4	6.5
Amsterdam	3.8	6.7
Paris	8.4	5.6
Bradford	4.3	9.2
Leipzig	8.3	7.5
Average, group I	5.3	4.5
Group II:		
Glasgow	12.5	6.4
Buda Pesth	9.4	13.6
Brussels	7.4	16.1
Dublin	15.7	12.2
Manchester	13.9	10.3
Moscow	13.8	15.0
Warsaw	13.5	17.4
St. Petersburg	25.2	33.7
Average, group II	13.9	15.6

Total population of group I, over 9,000,000; of group II, about 7,500,000.

TABLE III. TYPHOID DEATHS PER 100,000 OF 47 CITIES OF THE UNITED STATES HAVING POPULATIONS OF 100,000 AND OVER

	1909	1910
Birmingham, Ala	59.7	49.5
Los Angeles, Calif	16.1	14.2
Oakland, Calif	11.2	16.5
San Francisco, Calif	13.9	15.5
Denver, Colo	24.1	27.5
Bridgeport, Conn	9.0	4.9
New Haven, Conn	20.5	17.9
Washington, D. C	34.3	23.2
Atlanta, Ga	50.6	50.1
Chicago, Ill	12.6	13.7
Indianapolis, Ind	22.3	28.5
Louisville, Ky	45.0	31.7
New Orleans, La	28.4	31.5
Baltimore, Md	24.9	42.0
Boston, Mass	13.8	11.3
Cambridge, Mass	7.7	9.5
Fall River, Mass	21.3	15.0
Lowell, Mass	10.5	19.7
Detroit, Mich	20.5	23.0
Grand Rapids, Mich	17.2	28.3
Minneapolis, Minn	21.0	58.7
St. Paul, Minn	18.9	19.5
Kansas City, Mo	29.3	54.4
St. Louis, Mo	16.2	14.9
Omaha, Neb	36.8	86.7
Jersey City, N. J	8.8	11.5
Newark, N. J	11.9	13.1
Paterson, N. J	9.7	7.1
Albany, N. Y	19.0	14.0
Buffalo, N. Y	23.8	20.4
New York, N. Y	12.1	11.6
Rochester, N. Y	9.4	13.7
Syracuse, N. Y	11.2	28.2
Cincinnati, Ohio	13.3	8.8
Columbus, Ohio	19.6	18.1
Dayton, Ohio	26.9	21.4
Toledo, Ohio	41.7	37.2
Portland, Ore	22.0	22.4
Philadelphia, Penn	22.3	17.5
Pittsburg, Penn	24.6	27.8
Scranton, Penn	16.4	16.9
Providence, R. I	11.4	17.9
Memphis, Tenn	48.8	27.4
Richmond, Va	24.1	21.9
Seattle, Wash	23.8	14.2
Spokane, Wash	43.2	45.4
Milwaukee, Wis	21.4	45.7

25,000 population, while only four cities of over 100,000 population were in the 0-15 or the 70+ group; of these four, two were in the 52 cities in the 0-15 group and two in the 53 cities in the 70+ group.

The Taylor figures showed that about 100 of the 400 cities reported no typhoid deaths in some one of the years covered, while many cities ranged from zero to a very high figure, in one instance to 276 per 100,000.

We have referred to the Taylor figures to support our opinion that Dr. McLaughlin should have gone further in his statistics or not so far in attributing the low European typhoid rates to pure and the high American rates to impure water supplies.

Scanty indeed is the information which Dr. McLaughlin gives regarding the water supplies of European and American cities. He states that the high typhoid rate of St. Petersburg (25.2 in 1909 and 33.7 in 1910) is attributed to the water supply, "which is partly filtered and partly Neva water." He then adds:

> It is clear that in cities which have had safe water supplies for a period of years the [typhoid] rate should not be above 5 per 100,000 unless some unusual condition exists, such as poor control of milk or lack of control over patients or carriers. Now let us compare typhoid-fever rates in American cities.
>
> Table III shows our honor roll for 1909 and 1910. . . . One city, Bridgeport, Conn., has a rate below five. Three cities—Paterson, N. J., Cincinnati, Ohio, and Cambridge, Mass.—have rates below 10 per 100,000. Twenty-two other cities have rates of from 11 to 20 deaths per 100,000, and the remaining 24 cities have rates of from 20 to 80.

Further on, reference is made to the notable decrease of typhoid fever in the portion of Pittsburg, Penn., supplied with filtered water, and the high continuing rate in the (former) Allegheny City section, which still drinks unfiltered water. Mention is also made of typhoid outbreaks at Erie, Penn., and Baltimore, Md., which were attributed to polluted water. These references, and the statement relating to St. Petersburg, Russia, already mentioned, are the only data bearing on the relative character of the water supplies of the American and European cities, except the statement, which is important, that "In Europe surface-water supplies are almost invariably filtered."

Had Dr. McLaughlin presented data regarding the character of the water supplies of the 47 American cities in his list we think many of them would have been cleared of the apparent charge that the high death rates shown are due to the bad character of the corresponding water supplies. It seems to us that "poor control of milk or lack of control over patients and carriers" are usual rather than "unusual" conditions in many cities with high typhoid rates and that these rates will not be reduced to 5 per 100,000, or for that matter to 10 or to 15, until *usual conditions* other than those of water supply are greatly improved.

This does not mean that we would advise delay in providing improved water supplies. Rather we would urge haste in this good work, and at the same time equal haste in reorganizing the local boards of health and board-of-health work in not only the cities in the American list which show high typhoid rates, but also in most of the American cities in and out of the list.

Having indulged in some mild adverse criticism of Dr. McLaughlin's statistical data and conclusion we take pleasure in giving hearty approval to his sane remarks on sewage disposal in relation to water supply and his sound arguments for thorough methods of water purification, under constant and rigid control. Instead of crying out against all or any use of natural waters for sewage disposal by dilution he urges that each case must be decided on its merits; that advantage should be taken of the low cost of disposal by dilution where it will not endanger the water supplies of other communities or "put an undue burden and excessive responsibility upon the filter plants of those communities." Standards for raw and for filtered or treated water are urged, since these "would enable us to strike a balance between sewage purification and treatment of water, and to determine the degree of sewage purification necessary to assure a raw water of reasonable quality at a given point."

Reverting, in conclusion, to the question, what typhoid rate indicates a polluted or improperly purified water supply, raised by our opening paragraph and by Dr. McLaughlin's suggestion of 5 per 100,000, we do not believe that data yet exist which will answer the question conclusively. Nor do we believe that there is or for years to come can be any one rate applicable to cities of all countries or all parts of one great country. Before such a rate can be established, if indeed it ever can be, we must know far better than we do now the relative parts which other factors than water supply play in disseminating typhoid fever and to what extent and at what cost those factors can be controlled. Much as needs to be done in the way of improved water supplies, more needs to be learned and accomplished in the control of those other factors. It is particularly desirable that those who use the low typhoid figures of many European and a few American cities take pains to ascertain with more definiteness and certainty how much is really due to the high character of the water supplies and how much to other local and generally quite overlooked causes—not, as we have already stated, that the campaign for pure water be slackened, but that other sources and modes of infection become equally well known and brought under as high a potential degree of control.

The Loss of the "Titanic"

The greatest marine disaster ever recorded, the sinking of the White Star steamship "Titanic," the largest vessel afloat, with more than 1200 of her passengers and crew, is reported in wireless dispatches as this issue of ENGINEERING NEWS goes to press. From such reports as are now available it appears that the "Titanic," which was on her maiden voyage across the Atlantic, struck an iceberg at 10:25 p.m., April 14, when in lat. 41° 46′ and long. 50° 14′. Distress signals were sent out by wireless and at 10:55 the report that the vessel was sinking by the head. At 11:36 the "Titanic" reported that the women and children were being put off in life-boats; and she continued sending distress signals until 12:27 p.m.

According to reports by wireless from the "Olympic," on the evening of Apr. 15, the Cunarder "Carpathia" reached the scene of the disaster at daybreak and found only the life-boats, with less than 900 survivers, and floating wreckage from the great vessel, which sank about 2:20 a.m., when about 34 miles south of the point where she collided with the ice.

These are the bare outlines of the great disaster, gleaned from the more or less conflicting reports in the daily press. Fuller news concerning the survivors and the details of the catastrophe is anxiously awaited as we go to press, but it is altogether probable that all the technical particulars as to the wreck may never be accurately known.

At present attention is centered on the failure of the so called water-tight bulkheads to keep the ship afloat, at least long enough for help to reach her. That they did suffice to delay her sinking for four hours after the collision is evident. The most probable supposition is that the collision of the enormous hull with the floating ice mass destroyed the bow of the vessel, admitted water to the forward compartments and sank her head far below the water line. From this point the water gradually worked its way back, finding its way through the overstressed bulkhead partitions, some of which toward the forward part of the vessel may have been more or less strained by the collision.

It is not wholly news to engineers that it is more or less doubtful if water-tight bulkheads, as ordinarily installed in merchant vessels, can stay water-tight when subjected to the pressure due to a maximum head of water. Papers have been read in recent years before engineering societies pointing out structural weaknesses in the ordinary design of bulkheads, and urging that if these partitions were to really give the safety that they are supposed to insure, they should be as carefully designed to carry safely the maximum head of water as is a dam.

There are other questions which will occur to the minds of engineers, such as the inherent risk in steaming through dense fog at the speeds commonly held by passenger vessels, the wisdom of shifting still farther southward the transatlantic route from United States ports, and fuller provision of life-boats which, on the "Titanic," were capable of carrying only about one-third of the passengers and crew. Discussion of these and other questions, however, may well be postponed until the full particulars of this great disaster are known.

The 1912 Floods in the Ohio and Mississippi Rivers

By H. C. Frankenfield*

The flood in the Mississippi River now approaching New Orleans has reached heights never before recorded on the river. In this article Prof. Frankenfield, who is the flood expert of the U. S. Weather Bureau, records the history of the conditions preceding the flood and the stages of its progress down the river.

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The first great Mississippi River flood of which there is a record occurred in 1785, and it is said to have been the greatest flood in the history of the middle Mississippi Valley. Unfortunately the records are somewhat clouded, and the precise data of the flood of 1844 are now accepted as the high-water records for the lower Missouri and middle Mississippi Valleys. These floods also extended into the lower Mississippi Valley, and the flood of 1844 was always remembered as the greatest of all floods until the changing conditions of the last 30 years have resulted in other floods that have much diminished the fame that formerly attached to the older flood.

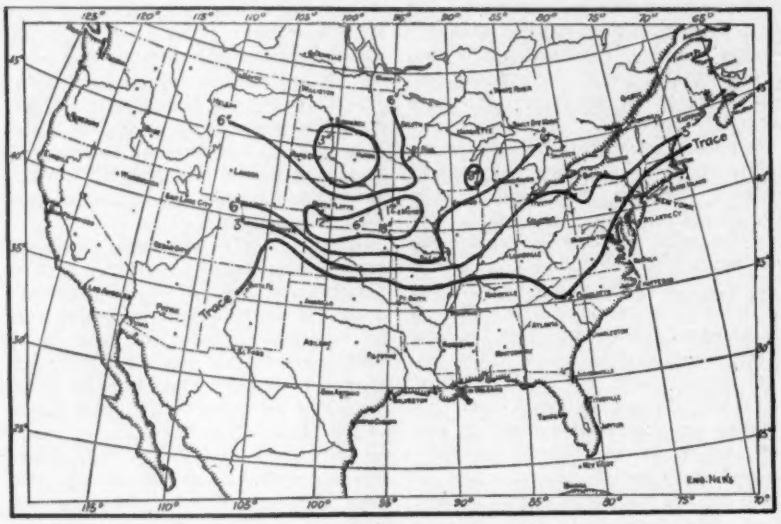
Floods in the Ohio and Mississippi rivers are usually similar in their inception and origin, and the general history of one is the history of all as far as essential details are concerned. A cold, early winter, resulting in a frozen soil and the accumulation of a considerable supply of unmelted snow over the Ohio watershed; then in February a storm, almost invariably from the southwest, accompanied by heavy rains and abnormally high temperatures over the Gulf States and the Ohio Valley. The ice in the Ohio River gives way, the runoff from the heavy rains is greatly augmented on account of the frozen soil, and the water from the melted snow is added to the total volume. In the meantime the rise in the lower Mississippi River has already set in, as this section is the first to be affected by the heavy rains. If there should be but a single storm, and the snow on the ground is not of unusually large quantity, the flood wave will be short and not of great height, but if, as sometimes happens, the southwestern storms move in a series, a fresh supply of water will be poured upon the watershed before the other has had an opportunity to run out, and a great flood sets in. If the rains are prolonged until late in March, the floods will receive a further increment from the rises in the upper Mississippi and the Missouri Rivers that come with the breaking of the ice after the first warm and heavy rain of the early spring season.

The flood of the present year, apart from the high stages reached, did not differ much as to characteristics from its predecessors, except that it set in about a month later than usual. January and February were cold with deficient precipitation as a whole, although there was a fair supply of snow on the ground at the end of February, with a further increase during the first half of March. The first southwestern storm passed over the Gulf States and the Ohio Valley on Mar. 11-12, attended by seasonable temperatures and rain in fair quantity. At this time the lower Ohio and lower Mississippi Rivers were at moderately high stages on account of an Ohio River rise in the earlier part of the month.

On Mar. 14-15, and again on Mar. 20-21, southwestern storms again moved over the Gulf States and the Ohio Valley, attended by moderately heavy rains, but not by very high temperatures. On Mar. 23-24 there was another, but this one was attended by abnormally high temperatures and excessive rains, with a fall of snow over Missouri and Kansas that was almost unprecedented for the season. On Mar. 28-29 there was another southwest storm accompanied by high temperatures and heavy rains, and still another on Apr. 1-2.

The accompanying charts show the amount of snow on the ground on Mar.

12, the date of the first southwest storm, and the total precipitation for the month of March. The precipitation was from 2 to 4 in. in excess of the normal amount over the lower Missouri, the Ohio, and



DEPTH OF SNOW ON THE GROUND ON MARCH 12, 1912

the middle and lower Mississippi watersheds, and owing to the frozen soil, a much larger percentage than usual of the total amount must have run into the rivers, carrying with it the water from the melted snows, which over the Ohio watershed must have amounted to at least an additional half inch.

The Ohio River began to rise immediately after the passing of the first storm on Mar. 11-12. The first flood warnings, covering that portion of the Ohio River from Evansville, Ind., to Shawneetown, Ill., were issued on Mar. 16, and on the morning of Mar. 18, the river at Evansville was 0.5 ft. above the flood stage of 35 ft. With the third storm on Mar. 20-21, the Ohio River at Cairo, Ill., passed the flood stage of 45 ft., and a flood set in over the upper Ohio, reaching a stage of 28.1 ft., or 6.1 ft. above the flood stage, at Pittsburg, on the morning of Mar. 22. The crest stage at Cincinnati was 53.4 ft. on Mar. 27, and at Louisville 28.7 ft. on Mar. 29, by which time the stage at Cairo was 51 ft., and at Memphis, 38.1 ft., 3.1 ft. above the flood stage, with the fifth southwest storm of the month in progress.

The heavy snows that fell over Kansas and Missouri on Mar. 23-24 had also melted, bringing the Missouri River east of Kansas City and the Mississippi from Saint Louis to Cairo almost to flood stage, and these waters contributed to materially increase the stage at Cairo and points below. With the arrival of the fifth storm on Mar. 28-29, it became evident that the highest stages ever known would occur between Cairo and Memphis, and, as soon as the sixth storm, that of Apr. 1-2, had passed, it was stated by the Weather Bureau that all records would be exceeded between Cairo and the mouth of the Mississippi River. Above Cairo the floods were not of great consequence, and they were of general interest only so far as they affected the stages below.

The accompanying table shows the highest stages reached during the present flood up to an including Apr. 13, the date on which this article is written, at which time the river was still rising from Helena southward. The table shows also the flood stages, and the stages reached during the other great floods of the last fifteen years.

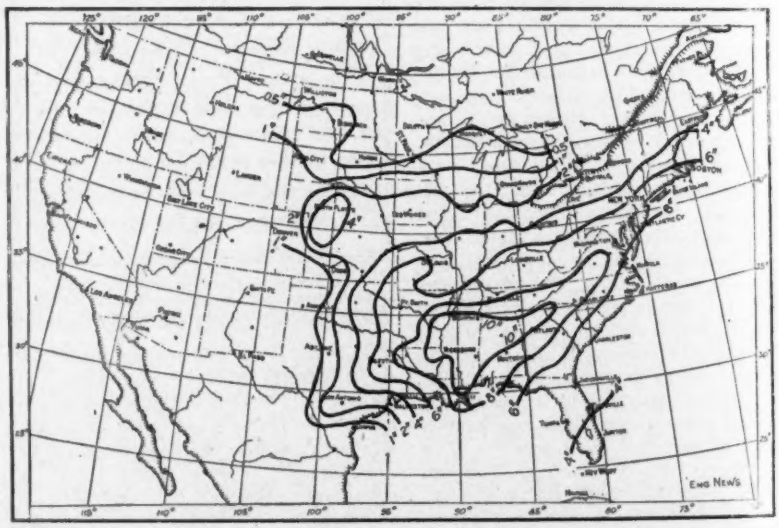
FLOOD CRESTS FROM CAIRO TO NEW ORLEANS

Stations	Flood stages	1912	1907	1903	1897
		feet and t			
Cairo, Ill.....	45	54.0	50.3	50	51.6
New Madrid, Mo...	34	44.0	39.3	39	40.2
Memphis, Tenn....	35	45.3	40.3	40	37.1
Helena, Ark.....	42	52.9	50.4	51	51.8
Arkansas City, Ark.	47	....	52.1	52	51.9
Greenville, Miss...	42	....	47.3	49	55.8
Vicksburg, Miss...	46	....	49.6	51	52.5
Natchez, Miss.....	46	....	48.9	50	49.8
Baton Rouge, La..	35	....	37.4	40	40.6
Donaldsonville, La.	28	....	30.0	32	32.8
New Orleans, La...	18	....	19.8	20	19.5

floods. The volume of water in 1912 was greater than in either 1907 or 1903, but less than in 1897, and that in 1907 the least of all; so that their order in point of flood volume would be 1897, 1912, 1903 and 1907.

It appears therefore, that measured by flood volume, the flood crest of 1897 should have been higher than any of its successors, yet it was not generally so. In 1903 and 1907, stages at many places from below Cairo to Greenville, Miss., were higher than in 1897, while in 1912, up to and including Apr. 13, the highest stages of record were measured from Cairo to Greenville, with a certainty of similar conditions to follow below if the levees remain intact.

The effects of the levees are particularly noticeable at Memphis. In 1897 the St. Francis levee extended from a point 106 miles above Helena, Ark., to Point Pleasant, Mo., and the left-bank levee from Hickman, Ky., to the high ground above Tiptonville, Tenn., did not exist. The highest stage at Cairo in that year was 51.6 ft., and at Memphis, 37.1 ft., a difference of 14.5 ft., with some broken levees on the right bank. In 1903, with a practically continuous levee from



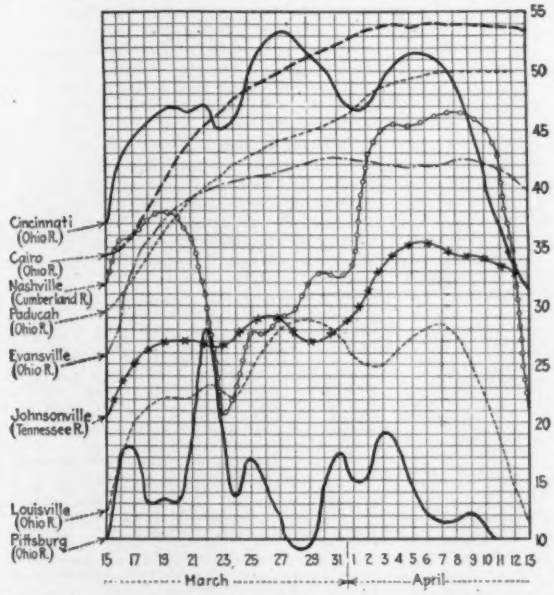
RAINFALL FOR THE MONTH OF MARCH, 1912

The above table is interesting chiefly as showing the effect of levee construction upon the river stages; but before drawing any conclusions it is proper to make some statements as to the actual water volume during each of the four

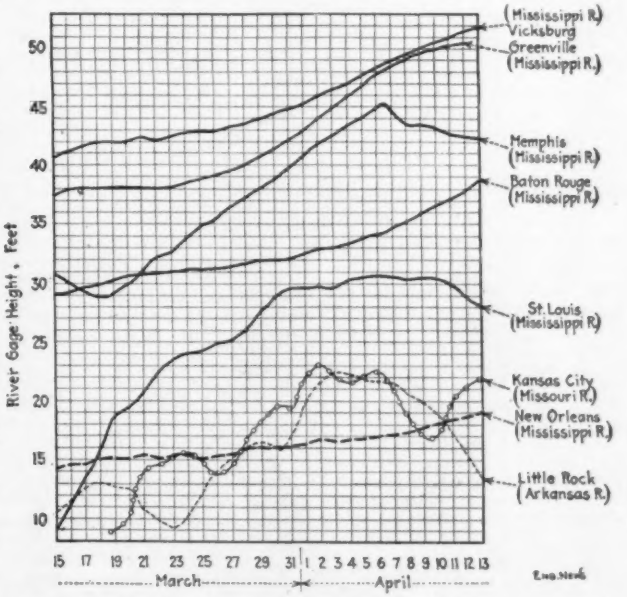
Point Pleasant southward, but with Reelfoot Basin still open, the crest stage at Cairo was 50.6 ft., and at Memphis, 40.1 ft., a difference of 10.5 ft., with a decrease of 1 ft. at Cairo and an increase of 3 ft. at Memphis, as compared with

1897. This notwithstanding the fact that the actual volume of water was less in 1903 than in 1897. There were some crevasses in the Arkansas levees, or the difference in stage between Cairo and Memphis would probably have been lowered to 9 ft.

In 1907, under practically the same conditions that obtained in 1903, except that the water volume was smaller, the crest stage at Cairo was 50.3 ft., and at Memphis, 40.3 ft., a difference of 10 ft. In 1912, with the levees nearly complete on both sides of the river, and with a volume of water less than in 1897, the crest stage at Cairo was 54 ft. and at Memphis 45.3 ft., a difference of only 8.7 ft., or 5.8 ft. less than in 1897. In the flood of 1882, before the levee era, with Cairo at 51.9 ft., the excess over the Memphis crest was 16.8 ft., or 8.1 ft. more than in 1912.



HYDROGRAPHS OF THE OHIO, CUMBERLAND AND TENNESSEE RIVERS, MARCH 19 TO APRIL 13, 1912



HYDROGRAPHS OF THE LOWER MISSISSIPPI, MISSOURI AND ARKANSAS RIVERS, MARCH 15 TO APRIL 13, 1912

This difference of between 8 and 9 ft in 1912 probably represents the actual gage relations now existing between Cairo and Memphis with unbroken levees, and indicates that the end has not yet been reached so far as extreme high stages are concerned. Before any of the levees gave way this year there was sufficient water in sight to have caused a stage of 56 ft. at Cairo, 2 ft. higher than the stage actually reached, and 3.4 ft. higher than the previous high-water mark of Feb. 27, 1883.

This stage of 56 ft. marks the capacity of the Cairo city levees, and, if it had occurred with the levees outside the city remaining intact, the crest stage at Memphis would certainly have been little, if any, under 48 ft., or 7.7 ft., above the previous high-water mark of Feb. 3, 1907. There would also have been a proportionate increase in the stages below Memphis.

Again, it must be remembered that this flood of 1912 came from the Ohio River and its tributaries. It is true that the lower Missouri and the upper Mississippi contributed somewhat, but the great bulk of the water came from the Ohio. The Arkansas River was in moderate flood only, while the Red River was not at all high. It is also true that there is no record of a flood in the lower Mississippi River caused by simultaneous floods in all of the large tributaries. As a rule, whenever the eastern tributaries were in great flood, the western ones failed, and *vice versa*, but the possibility of a combined flood is always present, and, if such a flood should come, the stages of 1912 would be exceeded below Cairo.

A final word as to the work of the Weather Bureau in connection with the floods. The Weather Bureau has to do only with the forecasting of gage heights and warnings of flood stages. The first warnings were issued on Mar. 15, and since that time the crest stages have been forecast for periods ranging from four days to four weeks in advance. Forecasts were always contingent upon the levees remaining intact, and thus far, with the crest of the flood near Arkansas City, Ark., the greatest variation of the actual from the forecast stages has not exceeded a few tenths of a foot. The breaking of the levees near Cairo was responsible for the only material change in the original forecasts for that place, and after the breaking, the corrected forecast was exactly verified.

The accompanying hydrographs show the stages reached at the principal places of observation, flood stages, or the stages above which overflow takes place, being indicated by a cross mark on each hydrograph. The hydrographs are not complete, of course, as the Mississippi River is still rising from Helena southward, and the crest of the flood will probably not reach the Gulf of Mexico until the end of April, or the first week of May.

A New River Channel at St. Paul, Minn., 2.46 miles in length, has been reported on by Oscar Claussen, city engineer, assisted by G. H. Herrold and others. The portion of the old Mississippi River channel which it is proposed to abandon is 3.07 miles long, but the thread of the deep-water channel would be shortened only 2200 ft. by the change. The new channel would have a width of 800 ft. at zero datum (10.4 river gage) and would throw to the north and east of the river an area of 713 acres, including 313 acres within the old harbor lines. The new channel would start near the Robert St. bridge and extend to a point opposite the upper end of Pig's Eye island. A harbor would be provided at the upper end, having a water area of 21,420 sq.ft., a width of 800 ft., a depth of 16.4 below zero datum and of 6 ft. below extreme low water. Below the harbor a low-water depth of 6 ft. would be maintained for a width of only 300 out of the 800 ft. of gross channel width. The total estimated cost of the work is $2,192,331. Of this $700,673 is for excavating 4,226,000 cu.yd. of material from the channel (18c. per yd.); $169,700 for concrete dock walls; $309,675 for riprapping, etc.; $292,490 for sewer extensions; $428,439 for land improvements, etc.; and $160,354 for engineering and various contingencies. The report was made by order of the city council. A meeting of the River and Harbor Commission of St. Paul was to be held on Apr. 15, at the call of Mayor H. P. Keller, to consider the report.

Two Powder Mill Explosions occurred, Apr. 4 and 10, respectively, the first at Northfield, B. C., at the Canadian Explosive Co.'s works, and the second at the Burton Powder Co.'s mill, near Lowellville, Ohio. In each case, one man was killed and one other injured.

A Ferry Boat Sank in the Nile River, Apr. 8, near the dam 15 miles north of Cairo, as the result of a collision with another steamer. Reports state that some 200 of the 300 people on board were drowned.

A Locomotive Boiler Exploded, Apr. 4, near Rice Hill, Ore., on the Southern Pacific Ry. Two men were killed and a number of loaded freight cars were demolished. The boiler was that of a helper engine coupled to a freight train.

A Church Floor Fell, Apr. 14, at Harrington Park, N. J., during the dedicatory services that were being held before the building was entirely completed. Two persons were killed and about 50 others injured. Reports state that about 300 persons had entered the church, which had a floor space of 40x60 ft., and that the floor gave way along a line down the middle of the church, from end to end. The congregation was heaped together in the trough formed by the two parts of the floor. Many thousand feet of loose lumber to be used in the interior finish of the church was piled along the walls, according to reports, and slid down among the people when the floor gave way. The floor of the church, it appears, was sustained only by temporary supports and the contractor claims that no permission had been given by him for holding services in the church.

A $50,000,000 Highway Bond Issue is to be referred to the people of the State of New York at the election next November. The bill providing for the referendum was signed by Gov. Dix on Apr. 13. One issue of $50,000,000 highway bonds has already been made by the State and the money so derived nearly exhausted in the construction of about 3000 miles of roads. If this additional sum is authorized the State of New York will have an indebtedness of $100,000,000 for highways and $120,000,000 for new canals.

Direct Contracts for Subway Franchises are authorized by a bill passed by the last New York legislature and recently signed by Governor Dix and by the mayor of New York City. The law is intended to enable New York City to negotiate concerning proposals to build and operate new subway lines, and close contracts, without submitting the contracts to competitive letting.

Federal Appropriations in Aid of Good roads are provided for by a bill introduced by Representative Hanna, of North Dakota, in the form of compensation for the use of highways for rural mail delivery. It is said that this bill has been agreed upon by a sub-committee of the House Committee on Agriculture as a substitute for some fifty different measures proposing federal aid for road construction. The bill divides highways used by rural free delivery carriers into three classes and awards compensation for the use of these roads at the rate of $25 per mile per annum, $20 per mile per annum and $15 per mile per annum for roads of class A, B and C respectively. Class A roads must have grades not exceeding 5% and must have a paved roadway not less than 12 ft. in width made of bituminous macadam, brick or macadam not less than 6 in. thick. Roads of Class B must have a paved surface at least 12 ft. wide of indurated clay, shells, sand clay or gravel not less than 8 in. thick. Class C includes any road which is kept well graded and drained and is kept smooth with a split-log drag so as to be reasonably passable at all times.

It is estimated that under the bill 54,000 miles of road would fall under Class A, 84,000 under Class B and 880,000 under Class C, and then an annual expenditure by the Federal Government of about $16,000,000 would be required.

Profits on New York City Bridge Contracts were revealed to the public as a result of a suit recently brought by Cornelius J. Sullivan against Patrick Ryan, for a division of the profits on the contract for building the Manhattan Bridge. The bid on this contract was $6,493,223, and the profit as revealed by the testimony in court was in the neighborhood of $1,800,000. The current idea that a contractor is a man with business experience, an organization and a plant capable of carrying on work efficiently and economically, was all wrong in this case, for Patrick Ryan, before taking this contract, was a concrete contractor. Sullivan was a member of an advertising firm, and he was engaged by Ryan on a promise of half the profits, for the aid and influence he could enlist; he is a member of a family that for years has been strong in local politics. While it appears that this influence was not enlisted, and that the contract was secured and the contract bond underwritten independently, yet the jury found in favor of Sullivan and awarded him several hundred thousand dollars. The New York "Times," of Apr. 12, quotes Sullivan as follows:

Mr. Sullivan stated yesterday that there had never been a bridge built in this city from which the contractors did not derive 50 per cent. profit.

"The Manhattan Bridge," he said, "did not cost over $4,000,000, and the Williamsburg Bridge, which was awarded on a $12,000,000 contract, did not cost over $8,000,000. So huge are the profits that an engineer's advice wouldn't do any good. Getting a contract is simply a matter of good guesswork."

Four 33,500-hp. Steam Turbines are to be installed in the Fisk St. station of the Commonwealth Edison Co., of Chicago. One of these is now being built in the Heaton works of C. A. Parsons & Co., Newcastle, England. It will be a horizontal type with high- and low-pressure cylinders, the former being a steel casting to avoid trouble of permanent extension and the latter arranged for double flow. These turbines will take steam at 200 lb. gage and 200° superheat and run at 750 r.p.m. The alternator for this unit (being built by the General Electric Co., of Schenectady, N. Y.) will generate at 4500 volts, this being stepped up to 9000 by an auto-transformer. Each turbine unit will be capable of carrying a load of 25,000 kw. continuously and of developing maximum economy at 20,000 kw.

The Fisk St. station was originally designed to house 14 generating units, each of a maximum capacity of 6000 kw. and maximum economy at 5000 kw. However, since the original installation was made, improvements in turbines and boilers have enabled the installation of 10 units, each having a maximum capacity of 12,000 kw. and an economical-load point of 10,000 kw., maintaining the same unit spaces in boiler room and in engine room as originally contemplated. The company has, therefore, a vacant piece of land which was originally intended for four units. It has been found that a careful design and selection of machinery enabled four units to be put in this place, each with a maximum continuous capacity of 25,000 kw. and maximum economy at 20,000 kw. The unit space of the building lengthwise will be increased 3 ft., the present width of boiler and engine rooms being maintained.

Panama Canal Excavation during March totaled 2,803,015 cu.yd., a daily average of 107,808 cu.yd. for the 26 working days. The amount of concrete laid during March was 128,375 cu.yd., and 582,755 cu.yd. of fill were placed in dams. The rainfall for the month was 0.15 in.

A Patent Decision on Flat Slab Floor construction was rendered at Minneapolis, on Mar. 29, by Judge Chas. A. Willard, of the U. S. District Court. The suit was brought by C. A. P. Turner against Moore & Scriver, owners of a building at 810 Nicolett Ave., Minneapolis, whose construction was claimed to infringe Turner's patent No. 985,119. The flat slab construction used in the building largely followed a patent issued to Wm. Pierce Cowles. The judge decided that Turner's patent was not infringed, because the so called "basket rods" used in the Moore & Scriver building did not correspond to the cantilever rods or the elbow rods described in Turner's patent.

An Expenditure of $100,000,000 in the improvements of Boston railway terminals is proposed by Governor Foss, of Massachusetts, as the condition of permitting the consolidation of the Boston & Maine and New York, New Haven & Hartford railway systems. A statement issued by the governor on Apr. 10 says:

The transportation problems of this State seem to me to have reached a critical situation. Our freight and passenger service is notoriously poor; and we are at a disadvantage as compared with other commercial districts and other Atlantic ports. Public service on the Boston & Maine, in particular, has practically broken down. The State exercises no real power of supervision and control over the railroads.

As a first step toward better conditions I have asked the Legislature to create a Public Service Commission with broad powers of regulation and control over the railroads and other public services. And now, because the railroad situation is so urgent, I have decided to go direct to the people of the State for a wide expression of popular sentiment on the following question:

If the Legislature creates a powerful Public Service Commission to control our railroad service, then are the people ready to permit the New Haven Road to lease the Boston & Maine on the condition that they expend $100,000,000 in the actual connection of the tracks on the north and south of Boston, making a four-track tunnel under Boston for that purpose, electrifying all their combined trackage within the metropolitan area and bringing the whole system up to the highest standard of efficiency?

No such lease ought to be granted unless the State first asserts its power of regulation and creates a commission powerful enough to enforce it.

The British Coal Strike may prove a blessing in disguise to British railways, according to the London "Times." Under the stress of impending coal famine, the railway managers canceled a large part of their train service, and it is now believed that a considerable proportion of these passenger trains will not be restored. Under stress of competition, numerous passenger trains have been placed upon the schedule which run much of the time half empty. By co-operation between the different lines in adjusting the hours of train service, it is believed to be possible greatly to reduce the number of trains with corres-

ponding reduction in operating expenses. The "Times" says: "If we understand the present movement aright, it virtually amounts to the future regulation of British railway traffic by a joint committee of the experts of all the principal lines."

Wholesale Vaccination against Typhoid fever, at Warrens, Wis., has recently been carried on on account of a threatened typhoid epidemic. The work was done by Dr. K. W. Smith, of the Hygienic Laboratory of the University of Wisconsin, who vaccinated 160 of a population of 250. Forty members of the Wisconsin National Guard, at Madison, were to be vaccinated by Dr. Smith, on Mar. 25, and the Hygienic Laboratory was furnishing anti-typhoid vaccine for the vaccination of national guardsmen in 17 other Wisconsin towns.

A Cofferdam Failure in Berlin, Germany, on Mar. 27, 1912, caused a serious interruption to the work on the new Spree River tunnel crossing of the Berlin subway, and stopped traffic on part of the subway for a time. The tunnel is being built between the corner of Wall and Insel Sts., and Kleine Stralauer St. The method used is like that used at Chicago; i.e., the tunnel is built in the open, under protection of a cofferdam, and to keep the river open one-half only is built at a time. The first half was completed in 1911, its river end being closed by a masonry bulkhead; the other half of the river was then cofferdammed. The river is 8 to 10 ft. deep, and the roof of the tunnel is 13 ft. below the river bottom. The cofferdam was nearly 60 ft. high from bottom of pit to water level. Its three sides were 6 to 10 ft. thick; construction not stated. One of the sides broke and flooded the cofferdam at about 4 a.m. The few men at work were able to get out. However, the finished half of the tunnel then began to leak, and water soon flowed in fast, flooding part of the subway. Dams had to be thrown across the tracks and pumps set to work behind them to enable traffic in the flooded parts of the subway to be resumed. The cofferdam failure is thought to be due to scour. (After a note in "Zeitschrift des Vereines deutscher Ingenieure," of April 6.)

A New Subway and Elevated Railway system for the City of Naples, Italy, was the subject of a government concession to a private company, on Jan. 18, 1912. The system comprises a metropolitan line entirely in subway through the business and resident sections of the city and a suburban line partly in subway, but mostly in elevated structure, which branches into two parts extending into the suburbs. The metropolitan subway is about five miles long and the suburban section comprises about 3000 ft. of subway with two separate three-mile elevated divisions. The subway will be standard gage two-track construction, 22.6 ft. wide and about 15 ft. high. The stations, which are spaced on an average of every 1800 ft., will be approximately 200 ft. long, providing for four 46-ft. car trains. Direct current at 1000 volts will be transmitted from a third rail in the subway and from an overhead catenary system in the elevated section. One notable feature of the subway is the great depth of the stations. At one point a station will be 516 ft. below the street surface. At all points where the station is above 40 ft. in depth the elevators will be provided. The total expense of the subway and elevated system is estimated to be $5,600,000.

Terne Plates Made from Ingot Iron have just been placed on the market by the American Rolling Mill Co., of Middletown, Ohio. The company has erected at its Zanesville plant six tinning stacks. Some difficulties have been found in rolling the ingot into thin sheets. The material is so readily welded that in rolling the sheets there was a tendency for them to stick together at the rolling temperature. These difficulties, however, are said to have been overcome. The plant has a capacity for 600 to 1000 tons of terne plates per month.

Personals

Mr. J. O. Derley has been appointed Village Engineer of Pleasantville, N. Y.

Mr. Thomas D. Cumberland, a judge of the county court at Brandon, Man., has been appointed Public Utilities Commissioner of Manitoba.

Mr. C. F. Parker, Purchasing Agent of the Illinois Central R.R., of Chicago, Ill., has been elected Vice-President of the Central of Georgia Ry.

Mr. H. Rettinghouse, Division Engineer of the Chicago & Northwestern Ry., at Boone, Iowa, has been promoted to be Division Superintendent at Mason City, Iowa.

Mr. F. C. Batchelder, formerly Vice-President of the Baltimore & Ohio Chicago Terminal R.R., has been appointed Assistant to the President of the Baltimore & Ohio R.R., and President of the Baltimore & Ohio Chicago Terminal R.R.

Mr. Paul Kreuzpointer, a metallurgist of the Pennsylvania R.R. for the past 32 years, has retired under the company's pension system. Mr. Kreuzpointer is 70 years of age and is one of the best known chemists in the service of the Pennsylvania R.R.

Dr. Ira Remsen, President of Johns Hopkins University, has resigned, to take effect at the end of the school year. Dr. Remsen's resignation is due to a desire to return to his more congenial research work, and he will continue as Professor of Chemistry at the University.

Mr. Gunni Jeppesen, for many years Designing Engineer of the Strauss Bascule Bridge Co., of Chicago, Ill., has been appointed Managing Engineer of the company. Mr. J. R. Hall, formerly Chief Draftsman, has been appointed Designing Engineer, and Mr. A. O. Walker has been appointed Chief Draftsman.

Mr. Philip E. Harroun, M. Am. Soc. C. E., a consulting hydraulic engineer, of Berkeley, Calif., has been appointed Engineer of the division of hydraulics of the California Railroad Commission. The new public utilities law of California gives the Railroad Commission jurisdiction over the valuation and regulation of all water utilities.

Mr. E. G. Connette, Assoc. Am. Inst. E. E., Transportation Engineer of the Public Service Commission of the First District of New York, has resigned, to take effect May 15. Mr. Connette has been with the Commission since September, 1909, previous to which he was General Manager of the Worcester, Mass., street railway system.

Mr. A. W. Thompson, M. Am. Soc. C. E., General Manager of the Baltimore & Ohio R.R. for the past two years, and 14 years ago a rodman on the Pittsburgh & Lake Erie R.R., has been elected Third Vice-President in charge of operation of the Baltimore & Ohio System. Mr. Thompson passed through all the engineering grades from rodman to Chief Engineer.

Mr. Luther D. Beckley, who has been with the Michigan Central R.R. for the past nine years as Assistant Engineer on the Western and Northern divisions, on grade-crossing elimination at Detroit, Mich., and most recently with the Detroit River Tunnel Co., has been appointed Village Engineer of Highland Park, Mich., where he will have supervision of all public works.

Messrs. A. L. Dabney and H. T. Cory, Ms. Am. Soc. C. E., have been engaged by the city of Augusta, Ga., to study a method for flood protection in that city. Mr. Dabney is the Chief Engineer of the Tallahatchie Drainage Commission, at Clarksdale, Miss., and Mr. Cory is a consulting engineer of San Francisco, Calif., who will be remembered by the readers of Engineering News as the author of the article on the Colorado River, in our issue of Dec. 7, 1911.

Mr. H. C. Nutt, formerly Fourth Vice-President and General Manager of the Northern Pacific Ry., Lines West of Paradise, has been appointed General Manager of the San Pedro, Los Angeles & Salt Lake R.R. Mr. Nutt began railway work as a rodman and for seven years was with the engineering staff of the Burlington & Missouri River R.R. He entered the operating department as Trainmaster and passed through the various grades to General Superintendent of the Chicago, Burlington & Quincy R.R., in 1905. For the past few years he has been with the Northern Pacific Ry.

Messrs. E. L. Grimes, M. Am. Soc. C. E., W. R. Headden and C. D. Calkins, of Troy, N. Y., announce that they have formed a partnership under the firm name of Grimes, Headden & Calkins, National State Bank Bldg., Troy, for the general practice of engineering. Mr. Grimes was for five years Chief Engineer of the bureau of water supply and for four years City Engineer of Troy. Mr. Headden has been connected with the city engineering department of Troy for five years, three of which he was Assistant City Engineer. Mr. Calkins has also been in the city engineering department and bureau of water supply.

Obituary

Erastus Corning Hawkins, Chief Engineer of the Copper River & Northwestern Ry., and of other Guggenheim railway properties in Alaska, died in New York City, on Apr. 9. He was born at Brookhaven, L. I., N. Y., in 1860 and attended Rensselaer Polytechnic Institute. After leaving college he was engaged in railway work in Colorado for a number of years. In 1898 he went to Alaska and was in charge of construction of the first railways built in that territory.

James Riddle Maxwell, M. Am. Soc. C. E., a consulting engineer of Newark, Del., and builder of the Central Railway of Peru, which reaches the highest alti-

tude of any railway in the world, died on Apr. 7. Mr. Maxwell began his railway work with the Pennsylvania R.R., and was engaged in location work for various Western railways for many years. In 1890 he went to Peru and was Engineer for the Ferrocarril Central de Peru between Callao and Oroya. This railway crosses the summit of the Andes at an elevation of 15,666 ft. above sea level, and was one of the most interesting pieces of railway construction ever undertaken.

Abbott Lawrence Rotch, Professor of Meteorology at Harvard University, died at his home in Boston, Mass., on Apr. 7. He was born in the same city a little more than 50 years ago and graduated from the Massachusetts Institute of Technology in 1884. In 1885 he established and had since remained in charge of the Blue Hill Meteorological Observatory, near Boston, where he gained international fame for his studies of air currents. Prof. Rotch began his investigations with kites and later used balloons. He took part in several scientific expeditions to South America, Europe and Africa, and was made a member of several foreign orders for his various achievements. He was an associate editor of the American Meteorological Journal in 1886-1896, and was the author of "Sounding the Ocean of Air" and "The Conquest of the Air."

Thomas Whyler Greene, Chief Engineer of the Minneapolis, St. Paul & Sault Ste. Marie Ry., died in Minneapolis, Minn., on Mar. 27, as noted in our issue of Apr. 4. Since publishing the obituary notice we have received the following additional information in regard to his earlier life: After a public-school education, Mr. Greene began work under S. B. Fisher, M. Am. Soc. C. E., on the construction of the Milwaukee & Western Ry. (now a part of the Chicago, Milwaukee & St. Paul Ry.) and continued in the engineering department of that company until he entered the service of the Minneapolis, St. Paul & Sault Ste. Marie Ry., in 1891, as an instrumentman, first under Mr. Fisher and afterward under the late Capt. W. W. Rich, M. Am. Soc. C. E. He rose rapidly to the position of Principal Assistant Engineer, and in 1898, when Capt. Rich was appointed Railway Adviser to the Chinese Government, Mr. Greene became Chief Engineer. His work as Chief Engineer is given in our previous note.

Engineering Societies

COMING MEETINGS

AIR BRAKE ASSOCIATION.
May 7-10. Annual convention at Richmond, Va. Secy., F. M. Nellis, 53 State St., Boston, Mass.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 14-16. Annual meeting at Chicago. Secy., F. H. Wentworth, 87 Milk St., Boston, Mass.

MASTER BOILER MAKERS ASSOCIATION.
May 14-17. Annual convention at Pittsburg, Penn. Secy., H. D. Vought, 95 Liberty St., New York.

AMERICAN RAILWAY ASSOCIATION.
May 15. Semi-annual meeting at New York City. Secy., W. F. Allen, 75 Church St., New York.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS.
May 16-18. Annual meeting at Pittsburg, Penn. Secy., F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 22-25. Annual convention at Chicago, Ill. Secy., D. B. Sebastian, La Salle St. station, Chicago.

INTERNATIONAL NAVIGATION CONGRESS.
May 23-28. At Philadelphia, Penn. Secy., J. C. Sanford, 344 The Bourse, Philadelphia, Penn.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
May 28-31. Spring meeting at Cleveland, Ohio. Secy., C. W. Rice, 29 West 39th St., New York.

AMERICAN WATER WORKS ASSOCIATION.
June 3-8. Annual convention at Louisville, Ky. Secy., J. M. Diven, 271 River St., Troy, N. Y.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
June 4. Annual convention at New York City. Secy., P. W. Drew, Soo Line, Chicago, Ill.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
June 10-14. Annual meeting at Seattle, Wash. Secy., T. C. Martin, 29 West 39th St., New York.

MASTER CAR BUILDERS' ASSOCIATION.
June 12-14. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 17-19. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago.

American Institute of Consulting Engineers—A meeting for discussing the question of "Engineer Commissioners" was held at the Engineers' Club, in New York City, April 17.

Engineers Club of St. Louis—On Apr. 17 a smoker was given in honor of Col. John A. Ockerson to commemorate his election to the presidency of the American Society of Civil Engineers.

Southern Engineering Society—An organization under this name has been effected by the architects and engineers of Augusta, Ga., with an enrollment of about 50 members. It is planned to have lectures and papers on subjects pertaining to all classes of engineering. The secretary is T. M. Campbell, 201 Terminal Bldg., Augusta, Ga.

American Society of Mechanical Engineers—An illustrated lecture by Dr. Rudolf Diesel on "The Development of the Diesel Engine" was given Apr. 18 under the auspices of this society before the Associated Engineering Societies of St. Louis, Mo.

Honorary membership in the American Society of Mechanical Engineers will be conferred upon Dr. Diesel at a meeting in New York City, April 30, at which he will repeat his St. Louis address.

Federal Furnace League—The annual meeting will be held at the Hotel Pontchartrain, Detroit, Mich., May 6. The morning session will be devoted to the routine business of the league. The afternoon session will be open to all furnace manufacturers and all manufacturers of furnace supplies and fittings. At this meeting will be announced for the first time the league's complete plan for the improvement of conditions in the furnace industry. The secretary is W. F. Colbert, 372 Bullitt Bldg., Philadelphia, Penn.

Southwestern Electrical & Gas Association—The eighth annual convention will be held at San Antonio, Tex., Apr. 25 to 27, at the St. Anthony Hotel. Among the papers to be presented are the following: "History of Street Railway Development in Texas," T. C. Brown; "Theft of Electric Current and of Gas," Harold L. Geisse; "Public Service Corporations and State Development," Louis J. Wortham; "The [illegible]ation of Power Factors to Central [illegible]ation Costs," Frank M. White. The secretary is Dan G. Fisher, 1316 Commerce St., Dallas, Tex.

London Society of Engineers—Two prizes of books or instruments to the value of $40 and $20, respectively, are offered for assays on the subject of "How to Improve the Status of Engineers and Engineering, with Special Reference to Consulting Engineers." The council reserves the right to withhold either or both of the prizes if the essays received are not of the required standard of merit. The competition is open to all, but application for detailed particulars should be made to the secretary before entry. The last date for receiving essays is May 31, 1912.

International Navigation Congress—An extensive program of excursions has been arranged to take place immediately following the close of the congress, which will be held at Philadelphia, Penn., May 23-28. The excursions are intended especially for the foreign members, many of whom from Germany, France, Belgium, England and Russia have already signified their intention of being present. Immediately after the close of the congress, May 28, the members will visit New York City, inspecting the harbor and docks under the guidance of Commissioner Tomkins, of the New York Department of Docks and Ferries. The party will then proceed up the Hudson River to Albany and along the line of the barge canal to Buffalo. After a visit to Niagara Falls, a trip on the Great Lakes will be made on a special steamer, possibly with stops at the Soo Locks and Chicago.

International Congress of Applied Chemistry—Among the additional papers announced in a recent bulletin to be presented before the eighth congress at Washington and New York, Sept. 4-13, are the following: "Effect of Pouring Temperatures on Tensile Strength of Aluminum Alloys," Horace W. Gillett, Detroit, Mich.; "A New Alloy with Acid Resisting Properties," S. W. Parr, Urbana, Ill.; "The Chemical Reactions of Autogenous Cutting," Alfred Stavenhagen, Berlin, Germany; "Some Physical Characteristics of High-Speed Tool Steel," J. A. Matthews, Syracuse, N. Y.; "The Heat of Absorption of Water by Wood," Frederick Dunlap, Madison, Wis.; "The Determination of the Relative Commercial Values of Wood Preservatives," H. F. Weiss, Madison, Wis.; "The Thermal Ohm, A New Unit of Thermal Resistance," Carl Hering, Philadelphia, Penn. The titles of some of the other papers to be presented before the congress were published in our issue of Mar. 21.

A total of 573 papers has been definitely promised for presentation before the congress. They will be divided among the sections of the congress according to the following classification: Analytical Chemistry; Inorganic Chemistry; Metallurgy and Mining; Silicate Industries; Organic Chemistry; Coal Tar Colors and Dye Stuffs; India Rubber and Other Plastics; Fuels and Asphalt; Fats, Fatty Oils and Soaps; Paints, Drying Oils and Varnishes; Starch Cellulose and Paper Center; Agricultural Chemistry; Bromatology; Physiological Chemistry and Pharmacology, and Electro Chemistry. The secretary is Bernhard C. Hesse, 25 Broad St., New York City.

Engineering Literature

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EDITORIAL

Under what is, so far as we know, a novel plan, every book added to the library of the Department of Mechanical Engineering of Worcester Polytechnic Institute is read by some member of the teaching staff. The reader or reviewer states in each case whether he thinks the book worth recommending for reading, and if so whether it is adapted for elementary, popular or technical purposes. Prof. William W. Bird, who is in charge of the department named and director of the Washburn Shop of the Worcester Polytechnic Institute, informs us that with the data noted above they are prepared to answer questions regarding books in their line, which questions are constantly being referred to the department by the Institute librarian, by readers, students and by public libraries.

Prof. Bird also states:

> If books are given to us, we put them on our shelves for one year, whether we approve of them or not, but we do not buy any books until they have been approved. That is, we secure a new book for examination, have a report made, pay for the book or return it. At the end of each year, we take out of our working library all old editions and books not favorably considered. So our working library consists of old books we think worth while and all the new books we can secure with our limited means.

The plan seems worthy of adoption elsewhere. It would make for better technical literature if copies of each opinion were supplied to the author and to the publisher of each book; perhaps this is done.

CORRESPONDENCE

Comments on the Review of Loewenstein and Crissey's "Centrifugal Pumps"

Sir—I have read with interest J. D. Berg's review of Loewenstein and Crissey's "Centrifugal Pumps," published in your issue of Feb. 15, 1912.

As you know, the Dravo-Doyle Co., with whom Mr. Berg is associated, are agents for the DeLaval Co., who manufacture centrifugal pumps, the design of which does not involve the use of diffusion vanes. As a result, Mr. Berg is naturally predisposed to favor the use of pumps without diffusion vanes.

Mr. Berg's statement that "a large majority of the centrifugal pumps in this country are constructed without diffusion vanes" is probably true if low-head pumps are included, but as there is no argument in the matter concerning low-head pumps, the statement should refer to high-head pumps only. On this basis the pumps with diffusion vanes are many times more numerous in this country as well as in Europe.

Mr. Berg seems to object to the use of diffusion vanes, due to the fact that they are subject to wear and corrosion, which is perfectly true, and it is also true that any part of the pump which comes in contact with the water moving at high velocities is subject to this same wear and corrosion. Consequently, if the diffusion vanes are omitted this wear and corrosion does not cease, as Mr. Berg would lead us to believe, but is simply transferred to whatever part of the pump the high velocity water comes in contact with, which is usually the casing; thus instead of the wear occurring on an easily replaceable diffusion vane, it occurs on the principal and most expensive part of the pump. From this point of view at least the diffusion vane would seem to be of some value. As the casings of the majority of pumps are constructed of cast iron, and must always be so, due to consideration of expense, the casing is not well adapted to withstand the action of the water moving at high velocities. By the use of diffusion vanes, however, due to their very small size and light weight, the vanes may readily be made of bronze, which withstands the corrosion of the high velocity water very much more satisfactorily than cast iron. The water passages, in the case of diffusion vanes, being of bronze can also be highly finished and remain in that condition for a long time. This results in a high efficiency, which is maintained throughout the life of the diffusion vanes.

The truth of these statements is well illustrated by the fact, recently brought to my attention, that one of the leading companies of this country manufacturing pumps without diffusion vanes has for some time been offering pumps against a head as great as 100 lb. per sq.in. per stage, but recently, due to the rapid corrosion of the casings, they have reduced this maximum to 80 lb. per stage, and there is no reason to believe that they will not have the same difficulty even at this lower pressure.

FREDERICK RAY,
Chief Engineer Alberger Pump Co.
140 Cedar St., New York, Mar. 8.

Sir—Even admitting for a moment the point made in the foregoing letter from Mr. Ray, the other disadvantages of diffusion vanes would seem to more than offset the advantage claimed for them in this instance.

If the casing and impeller are properly designed, the water should be so directed and its velocity such that when it reaches the casing serious scouring action cannot take place. If, however, a pump is so designed that it shows a performance as indicated by several curves reproduced in Lowenstein and Crissey's book, it is easily conceivable that other points of design tending toward the elimination of wear on the casing might be neglected.

On the other hand, on account of the necessity of having the diffusion vanes removable—as is mentioned by the commentator—it is extremely diffifficult to so fix them that they will not work loose. The tips soon become worn due to their being placed at a point where the velocity of the water is great, and if there is any possibility of foreign matter being present in the water, they become battered and useless in a short time. These difficulties in their use are aggravated in installations where the operating conditions (capacity, head and speed) are different from the conditions for which the pumps are designed.

The last paragraph of Mr. Ray's letter is interesting, although it would seem that a little more careful study of some important features of centrifugal-pump design would be of benefit to the company mentioned, as there are pumps without diffusion vanes working successfully

on higher pressures per stage than those mentioned, without any appreciable wear on the casing.

It might be logical to assume, however, that other causes than excessive wear on the casing may have influenced the manufacturer to reduce the allowable pressure per stage. One of these causes may have been the lack of an efficient joint between the suction and discharge spaces of the pump, as it has been shown by careful experiment that this provision is necessary to insure successful and continued operation.

J. D. BERG.

Pittsburg, Penn., Mar. 27, 1912.

On the Review of Royds' "The Testing of Motive Power Engines"

Sir—I have to thank you for directing my particular attention to the review of my book on "The Testing of Motive Power Engines," appearing in your issue of Jan. 18, 1912. On the whole your reviewer has given an appreciative account of the scope and object of the book, but there are one or two matters in which he seems to have been suffering from a temporary loss of his sense of proportion. In the third column, on page 130, he says:

> With the exception of the methods of measurement described in Chapters I and II all descriptions of the measurement of quantities are taken up as needed in carrying out the tests described. This method may appear to be the most logical from the teaching standpoint, but makes the book of doubtful value to the engineer who is laying out some test not described in the book and who wishes information concerning the various methods available for measuring certain quantities. . . . . "This objection is partially offset by a good index." . . . there is much valuable matter omitted which must almost inevitably be the case when subjects are treated in a disjointed manner and are taken up merely to fill some particular need.

Now, it is quite certain that the matters dealt with in Chapters I and II are best dealt with as general to the whole subject, but such an arrangement carried too far is particularly annoying to a busy engineer. Even if there might be an occasion for an engineer to make tests or experiments not described in the book, but within the scope of the subject, this event would be such a rarity as to be almost negligible in comparison with those occasions where the methods and apparatus described are applicable. Instead of the arrangement of particular descriptions being a disadvantage to the engineer, it is a distinct advantage to a busy man to be saved the trouble of wading through a mass of general descriptions in search of a suitable method for making common experiments.

With regard to the last part of the quotation given above, might I ask your reviewer to state what is the valuable matter omitted? If it is of such importance the author would be only too pleased to include such valuable matter in future editions.

In conclusion might I be allowed to state that there are 193 illustrations instead of the 83 stated in your announcement?

R. ROYDS.

The Glasgow and West of Scotland Technical College, Glasgow, Scotland, Feb. 1, 1912.

[The reviewer's reply to the foregoing letter follows. The misstatement of the number of illustrations was due to a typographical error, for which the reviewer was in no way responsible.—ED.]

Sir—Professor Royds takes issue with my adverse criticism of his arrangement of the subject matter of his book and with my statement that he omitted valuable information regarding instruments and methods of measurement.

As to the first point, the particular arrangement of subject matter which will best appeal to the engineer engaged in this class of work is a matter which is open to individual opinion. In my review I stated my opinion on the subject and gave my reasons for the position which I took.

As to the second point, I said in my review that much valuable information had been omitted, because in carefully reading Professor Royds' book I found no reference to many of the instruments and methods which have been developed comparatively recently.

Professor Royds requests that I definitely state what omissions have been made. I have searched through his book again and listed the instruments and methods of measurement of which I found no description. The following are the most important of the omissions noted: Sargent, Kent and Hoadley draft gages; diaphragm pressure gages; all types of recording pressure and draft gages; optical, radiation, expansion and fusion pyrometers; speed recorders; angular-velocity meters; all lubricant-testing apparatus; all types of automatic water meters and current meters; all forms of steam meters; carbon-dioxide recorders; Thomas electric steam calorimeter and Stott separating and throttling calorimeter; continuous steam-engine indicators; commercial forms of reducing motions, etc. All forms of speed indicators and revolution counters might be added to the above list, since but a single paragraph (which is not indexed) is devoted to the subject, in which a few types are mentioned.

The instruments listed above are not special forms of instruments described in the book but have been designed to meet conditions where the ordinary form of instrument would fail to give satisfactory results. Some of these on my list are mentioned by name in the book but they are not described nor is the reader given any information as to where a description of them may be found. While it might be contended that a few of the instruments I have named are seldom used, a book on this subject which claims to do more than explain the running of certain specific tests should enable the engineer to choose the method or instrument which best suits his particular purpose from all of those available.

HARRY L. PARR.

Columbia University, New York City, March 14, 1912.

GENERAL ARTICLES

Books for Engineers—A Criticism*

The duty recently fell upon the writer of recommending additions, to a limited value, of technical books for a student's library. Two or three impressions were gained by the search necessary to this duty. One was that a flood of technical books is emanating from America. Another old idea—which is, of course, likely to be criticized by the publishers—was confirmed, and that was the majority of technical books which are now issued are too expensive. That is certainly true of the books which come from America. In addition, there was the somewhat pathetic impression that many of the authors must have wasted hours of their lives upon work which proved of little service to anyone, of almost negligible remuneration to themselves, and not improbably a loss to the publishers.

Engineering literature may be roughly divided into two classes. There is that which is of a descriptive nature and deals with the details of work accomplished. A good example of this class is a paper read before, say, the Institution of Electrical Engineers, in which a large power station is described. Many of the contributions which form the basis of discussion at the meetings of the Institution of Civil Engineers are of this kind.

Literature of this type must of necessity always be in a state of flux. Changes in machinery and appliances are nowadays so rapidly brought about that no two similar schemes seem to be carried out in exactly the same way. Nor in engineering work does it often happen that the conditions of any two practical problems are identical. Thus there is a continuous adjustment to new ideas, and, in consequence, progress. The value of the kind of literature under discussion lies in the fact that before a man begins constructional or design work it enables him to become fully acquainted with the methods by which other engineers have overcome their difficulties. In this way he often gains an inspiration concerning an immediate and practical problem. For there are only two ways in which it is possible to gain knowledge—from men or from books.

*From an anonymous contribution to the Engineering Supplement of "The Times," of London, Jan. 31, 1912.

In general, it may be said that the proper method of communicating this class of work to the engineering profession is through the proceedings of technical societies or the current periodicals. It is literature which will quickly become out of date, and it is always very doubtful whether it will command a sufficient number of buyers to warrant the expense of producing a book. Some authors collect together a great deal of such descriptive matter from the sources enumerated above, and so make up a volume issued by publishers. At first sight it appears to be quite an easy thing to do. In actual fact it is one of the most difficult tasks which a man can set himself. Even if it is done very well, it is always an open question whether there will be a sufficient demand to compensate for the trouble. If it is done indifferently every one suffers—the buyer, the author, and the publisher.

The other class of engineering literature, which seems especially suitable for inclusion within the covers of a book rather than in a current periodical, is that which deals with the principles upon which applied science depends. These are the books which are usually written by the teachers of technology, though some of them have come from men actively engaged in practical design, as, for example, Seaton's classical book on the marine engine.

There are probably two reasons why teachers write such books. In the first place they have great experience in the art of making things clear to the student. It requires considerable experience, and no little ingenuity, to understand the difficulties of the average student, and very great patience is needed to see that the lame dogs are helped over the stiles. It therefore follows logically that a man who has had this experience is usually more fitted to write a book suitable for the understanding of the average intellect. Another reason why the teachers of technology write books is that they are compelled to prepare notes for their lectures and exercises for examinations and other purposes. These form a foundation for the book. A third reason is that the teacher often feels the absolute need of a certain type of book for the student. It is impossible during lectures to do more than cover portions of the field for the student of technology; the books must help over the remainder. It sometimes happens that the right book is not available and the teacher attempts to furnish it. It makes all the difference to the student whether there is a good treatise on the subject.

Of this type of book Rankine produced the most classical examples. They are still sold, after half a century, and they still form the inspiration for many technical authors. They are, however, not appreciated or understood by the 20th century engineering student, who is used to, and demands, something that is easier reading. Instead of these somewhat cumbersome volumes, the student needs, nowadays, a book on each particular branch of engineering work. And the price should be rather below than above half a sovereign ($2.50).

It sometimes happens that an expert in practical work is persuaded to write a book upon his own particular subject. Such an example is Sir William White's classical volume on "Naval Architecture." It is possible that the reason why that work has been of such service is not only because of the author's experience as a naval architect, but because of his experience as a lecturer at Greenwich. In fine, while it is an essential that the author of a standard work, suitable for men engaged upon highly specialized design or construction, should have great experience in his subject, he must also possess the faculty of clear exposition. Dugald Clerk has written such a book on gas engines. There are other similar books on boilers, irrigation, and many and various technical subjects. These standard treatises are invariably priced at something over a guinea ($5) and are thus usually beyond the reach of the student and any one not especially interested in the matter.

To come to the faults of the technical books which are now appearing so rapidly, many of them are badly written, badly arranged, and badly priced. Many authors do not appear to have in mind any definite purpose for their books. They do not seem to take the trouble to ascertain if such a book as they contemplate is really needed. They do not ascertain, before beginning their task, how far the field is already covered—in which respect they are like too many inventors. They often take no trouble about the general appearance of the pages.

A book on the elementary portions of a subject is, of all, the most difficult to write. It is so easy to leave out the essentials and to include the superfluous. In general, it may be said that, in a book for students, reproductions of photographs are unnecessary. What is required are line diagrams. These need to be carefully thought out and skillfully arranged. They should be drawn by a practiced hand. Above all, let the author resist the temptation to borrow blocks from a maker's catalog.

The recent increase in the number and duties of public service commissions has led to the establishment of a journal entitled *Public Service Regulation.* This journal, the first number of which is dated January, 1912, is published by The Traffic Service Bureau (30 South Market St., Chicago), and is the "Official Journal of the National Association of Railway Commissioners." The association just named includes in its membership the railroad and public service commissions of 42 states, as well as the Interstate Commerce Commission. The first number of the journal contains a variety of interesting articles on the problems and activities of public service commissions, together with decisions and orders of commissions. The new publication promises to be eminently useful.

A Bibliography of the Corrosion of Iron and Steel in Cinder Concrete

By Morton C. Tuttle*

The accompanying bibliography of the corrosion of iron and steel in cinder concrete, which is practically a complete one, has been compiled in the course of an investigation of that subject.

A variety of topics is treated in the 31 articles listed. Among the topics are the "Corrosion of Steel Reinforcements," "Rustless Coatings," "Chemistry of the Protection of Steel against Rust and Fire by Concrete," "Blast Furnace Slag," and quite a few others.

These references are from American, English, French and German publications, and result from an examination of the following: Engineering News, 1904 to 1909, inclusive; *Fortschritte der Technik*, 1910; *Transactions* American Electrochemical Society, 1902 to 1911, inclusive; *Proceedings* American Society for Testing Materials, 1903 to 1910, inclusive; *Engineering Index*, 1901 to 1910, inclusive; *Transactions* American Society of Civil Engineers, 1872 to Sept., 1911, inclusive.

The bibliography is as follows:

"The Corrosion of Steel Reinforcement in Concrete." By Ernest R. Matthews. Society of Engineers. Transactions for 1909, p. 61. A. S. E. Ackermann, Secy., 17 Victoria St., Westminister S. W., London, England. (Includes discussion of corrosion of metal in cinder concrete.)

Abstract of same. Surveyor and Municipal and County Engineer, v. 35, pp. 462, 495 (Apr. 9, 16, 1909).

"The Corrosion of Reinforcing Metal in Cinder-Concrete Floors." Eng. News, v. 56, p. 458 (Nov. 1, 1906). (Report of Committee to Structural Association of San Francisco.)

Editorial on same. Eng. News, v. 56, p. 461 (Nov. 1, 1906).

"More Evidence as to Possible Corrosion of Steel Imbedded in Cinder Concrete" (Letters). By A. L. A. Himmelwright and Charles C. Hurlbut. Eng. News, v. 56, p. 549 (Nov. 22, 1906). (Discusses the report of the Structural Association of San Francisco.)

"Rustless Coatings, Corrosion and Electrolysis of Iron and Steel." By M. P. Wood, New York, 1904, John Wiley & Sons, $4. (Discusses the effect of cinder concrete on metal in floors and steel framework of buildings.)

"The Action of Cinder Concrete on Steel" (Letter). By Ludwig Eld. Eng. News, v. 37, p. 186 (Mar. 25, 1897).

"The Chemistry of the Protection of Steel against Rust and Fire by Concrete." Eng. News, v. 47, p. 335 (Apr. 24, 1902). (Contains brief references to cinder concrete.)

"Report of the Science Standing Committee on the Rusting of Steel Inside a Concrete Covering." Concrete Institute, Transactions and Notes, v. 3, p. 128 (1911). (Contains data on the use of metal in coke-breeze concrete.)

*Secretary Aberthaw Construction Co., 8 Beacon St., Boston, Mass.

"The Effect of Electrolysis on Metal Imbedded in Concrete." By Cloyd M. Chapman. Engineering-Contracting, v. 35, p. 99 (Jan. 25, 1910.) (Results of experiments conducted by Westinghouse-Church-Kerr Co.; includes tests on concrete block made with cinder as a coarse aggregate.)

"Insurance Engineering Experiment Station, Report No. 4, Corrosion of Steel" (p. 36). Boston, Mass., Sept., 1902. Edward Atkinson, Director, 31 Milk St. (Contains report of Charles L. Norton on "Corrosion of Steel Frames of Buildings," giving results of tests for corrosion of metal in cinder concrete.)

Abstract of same. "Tests to Determine the Protection Afforded to Steel by Portland Cement Concrete." By Charles L. Norton. Eng. News, v. 48, p. 333 (Oct. 23, 1902).

"Insurance Engineering Experiment Station, Report No. 9." The Protection of Steel from Corrosion." (A brief report by C. L. Norton.)

Abstract of same. "The Protection of Steel from Corrosion." By Charles L. Norton. Eng. News, v. 51, p. 29 (Jan. 14, 1904.)

"Corrosion of the Steel Frames of Buildings." By Charles L. Norton. Technology Quarterly, v. 15, p. 343 (Dec., 1902). (The report is the same as that given to the Insurance Engineering Experiment Station.)

"The Removal of a Steel Frame Building." Eng. News, v. 49, p. 113 (Jan. 29, 1903). (Shows condition of floors and beams constructed with cinder concrete, of the Pabst Hotel, erected in 1898 in New York City.)

"The Corrosion of Steel in Reinforced Cinder Concrete." By William H. Fox. Eng. News, v. 57, p. 569 (May 23, 1907). (Describes experiments undertaken in the Thayer School of Civil Engineering.)

"More Concerning the Corrosion of Steel Imbedded in Cinder Concrete" (Letter). By A. L. A. Himmelwright. Eng. News, v. 56, p. 661 (Dec. 20, 1906).

"Corrosion of Steel in Cinder Concrete" (Letter). By A. L. A. Himmelwright. Iron Age, v. 79, p. 141 (Jan. 10, 1907).

"Reinforced Concrete Structures, the Corrosion of Reinforcing Metal." Iron Age, v. 78, p. 1667 (Dec. 20, 1906). (An Abstract of the report of a committee of the San Francisco Structural Association.)

"Blast Furnace Slag as a Structural Material." By Jos. A. Shinn. Engineers' Society of Western Pennsylvania Proceedings, v. 20, p. 157 (Apr., 1904). (Contains brief reference to the corrosion of metal reinforcement in concrete made with slag or cinders.)

"Serious Corrosion of a Steel Beam Protected by Terra Cotta and Concrete." Iron Age, v. 87, p. 486 (Feb. 23, 1911). (Data on the corrosion of a floor above a boiler room, supposed to be caused by vapors from wet ashes, carrying acid fumes, resulting from the sulphur in the ash.)

"Portland Cement Paint as a Protection to Structural Steel." By F. E. Giesecke. Cement Age, v. 9, p. 424 (Dec., 1909). (Merely states that steel imbedded in dense concrete will not rust; it does not matter whether the aggregate employed in making the concrete is gravel or cinders.)

"A Treatise on Concrete Plain and Reinforced" (p. 327). By Frederick W. Taylor and Sanford E. Thompson. Second Edition. New York, 1909. John Wiley & Sons. $5. (Gives abstracts of results of tests with cinder concrete, by Charles L. Norton.)

"Le Béton Armé et ses Applications," p. 702. By Paul Christophe. Paris, 1902. $4.75. (Contains two pages on the pernicious effects of using reinforced concrete made with cinders.)

"Concrete and Concrete Steel in the United States." By Edwin Thacher. Transactions American Society of Civil Engineers, v. 54, Part E, p. 443 (Inter. Eng. Congress, Paper 70). (Gives results of experiments of Charles L. Norton, with cinder concrete.)

Brief abstract of same. "Beton und Eisenbeton in den Vereinigten Staaten Nordamerika." By Edwin Thacher. Beton und Eisen, v. 4, p. 77 (Apr., 1905).

Handbuch für Eisenbetonbau, v. 4, p. 1, p. 35; edited by F. von Emperger. "Bauausfuhrungen aus dem Hochbau und Bausetze," by Salinger and others. Berlin, 1909. Wilhelm Ernst & Sohn. 35 Marks. (Contains eight pages on the rusting of iron in concrete.)

"The Preservation of Materials of Construction, an Informal Discussion." Trans. Am. Soc. C. E., p. 303 (Paper No. 949, June, 1903). (Contains observations by Mr. Hill on condition of reinforcing metal in cinder concrete.)

"Sind Lokomotivlosche und Koksasche als geeignete Zuschlage für beton zur Herstellung und Massiv-Decken zu betrachten." By Julius Donath. Deutsche Bauzeitung, Mitt lieber Zement, v. 41, p. 40 (1907).

"Some Hints as to Reinforced Concrete Construction." Journal of Gas Lighting, v. 80, p. 1606 (Dec. 16, 1902).

REVIEWS

Geodetic Surveying

Reviewed by JOHN F. HAYFORD*

GEODETIC SURVEYING AND THE ADJUSTMENT OF OBSERVATIONS—By Edward L. Ingram, C. E., Professor of Railroad Engineering and Geodesy, University of Pennsylvania. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. 389; 92 text illustrations. $3, net.

The author states that no attempt has been made to treat the subjects indicated by the title of the book "exhaustively for the benefit of the professional geodesist, but rather to build up a book containing everything that can be considered desirable for the student or useful to the practicing civil engineer."

The following excellent statement of aims is quoted from the preface of the book, the numbering of items being inserted, however, by the reviewer:

> In the preparation of the text the following points have been kept constantly in view: (1) to bring the book up to date; (2) to make the treatment of each subject as clear and concise as possible; (3) to use the same symbols throughout the book for the same meaning, adopting the symbols having the most general acceptance; (4) to define each symbol in a formula where the formula is developed, so that the user of the formula is never required to hunt for the meaning of its terms; (5) to give for every formula the unit in which each symbol is to be taken; (6) to clear up any doubt as to what algebraic sign is to be given to a symbol in a formula, as the sign required in a geodetic formula is not infrequently the opposite of what would naturally be supposed; (7) to make perfectly rigid such demonstrations as are given; (8) where demonstrations are not given to state where they may be found; (9) to give the best obtainable values for all constants required in geodetic work; and (10) to state the accuracy attainable with different instruments and methods, so that a proper choice may be made.

This statement tends to arouse in the reader both interest and high hopes. The author is to be commended for the unusual success he has attained in connection with the aims numbered 2 to 6 and 9. A careful reading of the book fails, however, to disclose convincing evidence that the author made any serious effort to fulfill the promises in the remaining stated aims, numbered 1, 7, 8 and 10.

The book is inexcusably out of date in many parts. The statements (pp. 7-8) in regard to the strength of figures in triangulation, among them being the statement that "The best shaped triangle is evidently equilateral," though found in many old books, are now known to be erroneous, and the errors have already been corrected in two standard books on surveying which appeared before [illegible] one. The author has not yet discove[illegible] (p. 23) that acetylene signal lights a[illegible] used in triangulation though the fact [illegible] that for at least nine years they have [illegible]ractically superseded all others in the [illegible]nited States for night observations. Similarly, he has not discovered that base bars have been superseded in the United States by tapes. It is stated that the best class of precise leveling "is only possible during a few hours of the day" and that it becomes impracticable "when the wind reaches about eight miles an hour" (pp. 144-156). Ten years ago these two statements were proved untrue and the proof has been continuously furnished ever since by hundreds of miles of precise leveling of the highest grade done each year by the Coast and Geodetic Survey. These are but four examples selected from many that might be given.

There are many formulas in the book for which no rigid demonstrations are given and no statements made to show where the demonstrations may be found. In this respect the book is more faulty than any other the reviewer has examined. For example, among the formulas given without demonstration or any definite reference to the demonstration elsewhere are those for computing the reduction to elongation in connection with azimuth observations (p. 210), for computing the true length of a degree of latitude or longitude (p. 228), for computing from residuals the probable error of a single observation or a mean value (pp. 263, 299-300). These are all important formulas. The ones dealing with probable errors are fundamental in character. Similarly at the top of p. 303 will be found a fundamental formula of least squares given in the form of a rule, but no rigid demonstration or reference to a demonstration is given.

The statements as to accuracy vary greatly in different parts of the book in the judgment shown in making them and in clearness of expression. One who knows past experience in this line is skeptical of the statement that by making several determinations of a longitude by lunar occultations "an accuracy approximating a tenth of a second of time is attainable" (p. 199) and one wonders as to the exact meaning of the word "accuracy" as here used.

In such a book as this is claimed to be, one has a right to expect that the present state of the art is properly represented, especially in statements made in such a form as to indicate that they represent current good practice. Naturally when one finds on page one a statement which apparently means that all geodetic work in the United States is carried on by the Coast and Geodetic Survey, one expects the book to represent the current practice of that organization unless otherwise stated. One is surprised, therefore

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to read (p. 31) the statement that in the common method of measuring bases with steel tapes movable tripods are used; that tapes used in base-line measurements are "generally standardized supported horizontally throughout their length" (p. 34); that with a direction theodolite "in the highest grade of work the limb of the instrument is shifted between each set of readings an amount equal to 180° divided by the number of sets" (p. 61). These and many other statements which might be cited grossly misrepresent current good practice. Page 158 apparently indicates that the author has never heard of supporting a precise leveling rod on a railroad rail in place though that practice, where it is possible, has superseded both the foot-plates and foot-pins which he mentions. A freak method of writing the condition equations in a quadrilateral adjustment is given (p. 326) which will be interesting to those who have spent years in such adjustments, using an easier and a better method.

Is the use of such poor English as that in the following sentences to be willingly tolerated in a book intended for the use of college students? "After the sun has risen a couple of hours above the horizon until noon the image gradually gets more and more irregular in outline" (p. 23). "By mean sea level is meant the average elevation of the surface of the sea due to its continuous change of level" (p. 125). These are but two examples selected from many that might be quoted.

The reviewer finds that a single reading of the book justifies the marginal note, "Not true," in at least ten cases. How many cases would one find if he used the book as a text? "If all the triangulation stations (referred to mean sea level) were connected by chords instead of arcs, we would have a net-work of plane triangles perfectly locating all the stations" (p. 88). The author then states clearly that by the application of corrections for spherical excess the angles of these plane triangles are secured. This is an error frequently made by students but here inserted in a book on geodesy. "The size of the largest quadrilateral occurring in practice is relatively so small as compared with the size of the earth that we may always assume without material error that the four stations lie in a plane" (p. 90). This statement causes wonder since the assumption is not ordinarily made and is inadmissible.

The part of the book dealing with adjustment of observations is positively harmful since if the methods therein contained were followed in good faith the result would be the abuse rather than the use of the method of least squares. For example, it is stated (pp. 336-337) that "a consideration of the various methods and instruments used in measuring base lines also shows that there is nothing in any case which can materially modify the truth" of the proposition that "the probable error of a base line varies directly as the square root of its length." In the history of base measurements there is abundant evidence that the unavoidable errors in standardizing the bars or tapes used produces serious errors proportional to the length of the base, thus rendering the statement of the preceding sentence untrue and making the method of computation of the probable error of the base set forth in this book inadmissible. This is but one of many citations which might be made to show the danger of following this book in least squares. This citation contains both an error in statement of fact and a dangerous error in theory.

The list of books on geodesy and least squares given (pp. 374-376) is excellent. Students of geodesy and civil engineering will do well to use the books of this list until the author has shown due respect to these books by using them in bringing his own book up to date and correcting its many errors of statement and of judgment.

THE UNITED STATES NAVY—A Handbook. By Henry Williams, Naval Constructor, U. S. Navy. New York: Henry Holt & Co. Cloth; 5x7½ in.; pp. 228; many plates. $1.50, net.

The author states that at one time he was frequently called upon to prepare answers to letters to the Navy Department requesting information about the Navy. The present volume was prepared to fill the need indicated by these letters. It is not technical in its language or treatment and only subjects of general interest are discussed.

In the opening chapter on "Naval History" the author briefly sketches the origin and development of the U. S. Navy. Army men will no doubt consider that he overestimates the importance of the Navy in American history, and this attitude as to the relative importance of the Navy is consistently maintained in the final chapter on "The National Defense," in which the author states that a nation's surest guarantee of peace is to be at all times ready to wage war successfully and that in order to secure such a guarantee an efficient fighting navy is essential. In the author's opinion the United States can well afford to pay so cheap an insurance for peace and immunity from war as is involved in the cost of the Navy.

The intermediate chapters take up the Navy's organization, its personnel, the placing of a vessel in commission, classification of naval vessels and a general description of an armored ship. There are also chapters on high explosives, mines, torpedoes, etc., and on the designing and building of a warship, together with some description of modern dry docks. The book is illustrated with a number of photographs and a few diagrams. The photographs show old naval vessels of historic interest as well as more modern battleships and cruisers. There are also photographs showing collar devices and other insignia or badges of naval officers. No particular naval vessel is described and there is no diagram showing the interior arrangement of a battleship, the idea being apparently to limit the information given to a general knowledge of naval vessels and of naval organization and methods.

AN INVESTIGATION OF THE AIR LIFT PUMP—By Geo. Jacob Davis, Jr., C. E., and Carl Robert Weidner, C. E., Assistant Professor and Instructor (respectively) in Hydraulic Engineering, University of Wisconsin. Madison, Wis.: The University, Bulletin No. 450, Eng. Series. Paper; 6x9 in.; pp. 167; illustrated. 40c., net.

For years the air-lift pump has been an attractive device for raising liquids on account of its extreme simplicity. But in spite of this, actual data on the performance of air lifts of size have been scarce and little has been known of the effect of the many variables in design and use.

The several series of tests described at length in this bulletin comprised over 600 experimental runs of different air lifts under various conditions. The details of apparatus, method of experiment and of computation are given at length so that the results are of the greatest possible utility. The bulletin also gives the historical development of the air lift, notes on the theories of its action advanced by different writers and discussions of the data obtained regarding inter-relations of submergence, lift, quantity of air used, structural features, discharge and efficiency.

The general conclusions of the study are given under 12 heads, as follows:

(1) The central air-tube type has the greatest theoretical capacity; (2) the coefficient of pipe friction and slip decreases as the discharge and the air-to-water ratio increase; (3) this coefficient varies with the pump length, but is independent of submergence and lift; (4) with fixed pump length, submergence and lift, a definite quantity of air gives a maximum discharge; (5) with constant pump length the maximum work comes at the same percentage of submergence for all rates of air consumption; (6) with given pump length, submergence and lift, highest efficiencies accompany lowest rates of pumping; (7) with fixed pump length, but varying submergence (and therefore varying lift) maximum efficiency was obtained at 63% submergence for all rates of air input or water delivered; (8) with constant lift, the efficiency increases with the percentage of submergence for all inputs; (9) with fixed submergence, the efficiency of a given size and type increases with the lift (with extensions of delivery pipe) although there probably is a point where efficiency falls with increased lift; (10) there is no advantage of introducing compressed air above the water surface of a well; (11) type of footpiece has little effect on efficiency so long as there are unrestricted passages, but a nozzle (to increase the kinetic energy of the air) is detrimental; (12) a diverging outlet (to conserve the kinetic energy of velocity head) increases the efficiency.

"Oil Fuel" is the title of an attractive little book issued by The Texas Co., of New York City and Houston, Tex. Although a trade publication, the book merits mention here because of the general information and data which it contains.

The Sun to Date

Reviewed by Geo. C. Comstock*

THE SUN—By Charles G. Abbot, S. M.; Director Smithsonian Astrophysical Observatory. New York and London: D. Appleton & Co. Cloth; 5x8 in.; pp. 448; 26 plates and many text illustrations. $2.50, net.

A generation of Americans have looked to Young's "The Sun" as an authoritative summary of knowledge regarding our chief luminary. Ready access to so excellent a text has perhaps diverted popular attention from the great advances that have been made since its publication. In offering to the public an avowed substitute for the above-named classic, Mr. Abbot emphasizes among these recent advances Rowland's solar-wave-length investigations, spectrum photography as applied to the corona and photosphere, the discovery of magnetic fields in sun spots, the detailed investigation of the sun's rotation at different levels and in different latitudes, and his own protracted studies upon the absolute intensity of the solar radiation. This new material is to be worked over and assimilated to the old, theories of the solar mechanism are to be reviewed and an account of the sun presented in language intelligible to the lay reader, although in part the matter here presented has not hitherto been accessible even to the professional astronomer.

Following two chapters of introductory matter not markedly novel in kind, the author enters upon a somewhat detailed survey of the sun's anatomy, the photosphere, sun spots, faculæ, prominences, the corona, etc., with small heed to theory and with especial emphasis upon recent observation. Having thus given about half of his text to an exposition of data, Mr. Abbot proceeds to correlate and digest these data, raising first the inquiry, What is the sun? contrasting the various theories that have commanded attention in the past two decades and adding to them his own dissenting views, characterized by the assumption that the sun, excepting perhaps in sunspots, is wholly gaseous or vaporous, its apparently well defined boundary surface, the photosphere, being unreal and due chiefly to dissipation of light in the sun's outer envelopes.

Then follows a chapter upon the sun as the earth's source of heat, including possible fluctuations in this supply and their bearing upon the temperature of geologic times as well as upon the short-period fluctuations to which terrestrial climate and weather seem subject at the present day. For the biologist there is a chapter upon the sun's influence on plant life and for the engineer one upon methods of utilizing the solar energy as a source of power. The author's generalization that while much labor and ingenuity have been bestowed upon devices of this kind, they have upon the whole been found inefficient, will probably command a general assent that may perhaps extend to his somewhat optimistic view of possible future developments along this line.

The final chapter of the text deals with the sun as a star, its relation to the sidereal system, and the indices of structure and organic evolution of the cosmos that are to be obtained through the comparative stud of solar and stellar spectra.

With reference to the wide range of subject matter thus indicated, the book may fairly be called a popular treatise, but it combines with this function that of presenting for the first time the outcome of the author's own research upon the amount and suspected variations in the output of solar energy and the part played by the terrestrial atmosphere in influencing the effect of this energy upon the surface of the earth. While these investigations have been somewhat sharply criticized (as is usual) their scope and character are such that they must command technical attention and their inclusion in the text here considered, together with a considerable amount of other matter not yet bearing the stamp of orthodoxy, adds to the interest and value of a work that may be heartily commended to the engineer as well as to the student of pure science.

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THE RENAISSANCE IN ITALY, FRANCE AND ENGLAND—By F. M. Simpson, Architect; Professor of Architecture in the University of London; F. R. I. B. A.; Sometime Professor of Architecture in the University of Liverpool; Royal Academy Traveling Student, 1884. Being Vol. III of "A History of Architectural Development." New York and London: Longmans, Green & Co. Cloth; 5¾x9¼ in.; pp. 359; 268 text illustrations. $6, net.

A readable account of Renaissance architecture, well illustrated with plans, details, perspective sketches in pen and ink and in halftone, rounds out Mr. Simpson's "History of Architectural Development." (The earlier volumes dealt with "Ancient, Early Christian, and Byzantine" and with "Medieval" architecture.)

The author's story of the Renaissance begins with its rise in Florence, about 1430, and continues with its spread and later sway over Italy. A chapter on "Renaissance Domes, their Design and Construction," promises to be of particular interest to engineers, although space limitations prevent the author from going into much engineering detail.

Italy having been given nearly half of the book, France is taken up in about fifty pages, thus reserving liberal space to England. The most interesting chapter here is the one on "Inigo Jones, Christopher Wren and London Churches," though the whole of this section, and for that matter of the entire volume, is full of interest. A brief final chapter deals with the battle of the Gothic and the classic in the nineteenth century, the later "Queen Anne movement," and finally the recent return to "the art of [illegible] planning."

Any engineer who wishes to be well rounded as a man should have some general knowledge of architecture. If he is so fortunate as to be able to accumulate a library he will find a relatively brief but comprehensive history of architecture, like the one of which this volume forms a part, a valuable addition to his other books. The civil engineer, and notably the city engineer, in these days of town planning, has particular need of at least a general knowledge of the history and principles of architecture.

U. S. COAST AND GEODETIC SURVEY—Department of Commerce and Labor. Report of the Superintendent (O. H. Tittmann) showing the progress of work from July 1, 1910, to June 30, 1911. Washington, D. C.: Pub. Doc. Cloth; 9¼x12 in.; pp. 584; five progress sketches and four maps in pocket of cover; three maps and 40 text illustrations.

Besides the usual detail report of the progress of work of the Survey, this volume contains an appendix (3) giving the magnetic elements of a large number of stations and the geographic positions on the U. S. Standard (final) Datum of more than 1500 new triangulation stations in Nebraska, South Dakota, North Dakota, Minnesota, Wisconsin, Texas and Florida. The stations have been marked substantially and the published descriptions make their recovery easy. As more and more private land surveys are being based on the U. S. Triangulation a description of these stations may be of value to engineers and surveyors in the states mentioned.

The disposal of wastes from beet-sugar factories was investigated in 1909-10 by Thos. S. Ainge, sanitary engineer, and Dr. M. L. Holm, bacteriologist, of the Michigan Board of Health. The results of their studies are presented in condensed form (13 pp.) in the report of the board for the year ending June 30, 1910, recently published. Mr. Ainge visited Germany in the course of his investigations, accompanied by officials of Michigan beet-sugar companies. An illustrated summary of his foreign observations is given in the report.

The use of "permutite" for water purification and softening is reviewed editorially by W. A. Hamor in *The Journal of Industrial and Engineering Chemistry* (Easton, Penn.). References to articles on the subject and to foreign and American patents are given. It may be added that permutite is an artificial zeolite burdened with the following formula:

$$3\,SiO_2.\,Al_2O_3\,(K_2O.\,Na_2O.\,CaO).\,6\,H_2O.$$

One would suppose that the worst of waters would hardly be able to withstand treatment by such a substance. Yet outside of laboratories and patent offices the permutite process does not seem to have made much practical headway.

Heat and Thermodynamics

Reviewed by LIONEL S. MARKS*

HEAT AND THERMODYNAMICS—By F. M. Hartmann, in charge of the Department of Physics, and Electrical and Mechanical Engineering, Cooper Union Day and Night Schools. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. 346; 72 text figures. $3, net.

Works on thermodynamics are appearing so rapidly at present that it is necessary for each new one to offer some special justification for its existence. The present author has found by experience that a short course on the fundamental principles of heat, given as an introduction to the subject of thermodynamics, greatly reduces the difficulties experienced by most students in pursuing that subject. Consequently, he has written a book in which the first quarter is devoted to the subject of heat, and the remaining three-quarters to thermodynamics.

It is not easy to see on what principle the subject matter has been divided into "heat" and "thermodynamics." The chapters grouped under "heat" are on temperature and thermometers; calorimetry; the effects of heat and reversible processes; the expansion of solids and liquids; the properties and fundamental equations of gases; the relations between six thermal capacities of matter and the properties of vapor; isothermal, adiabatic and other expansions of gases, and the ratio of the specific heats of gases; propagation of heat by radiation and conduction. If we except the chapters on calorimetry and the propagation of heat, all the other chapters enumerated consist mainly of matter which is usually included in modern textbooks on thermodynamics. The separation of this matter from the rest of the text does not accomplish anything of real value, but on the contrary interferes with the best logical development of the subject.

An engineering textbook, in order to compel the attention of the earnest student, should have that vital quality which usually results from the close contact of the author with the problems of the engineer. Unfortunately, the author has not succeeded in giving that quality to his book; it is wordy without being illuminating, and is distinctly labored. The derivations of equations are painfully complete, no intermediate step being omitted, as for example, on p. 106, where the isothermal equation for a perfect gas

$$p_1 v_1 = p_2 v_2 = RT_1,$$

is found to yield

$$p_1 = \frac{RT_1}{v_1}$$

and

$$p_2 = \frac{RT_1}{v_2}$$

while the similar equation

$$p_3 v_3 = p_4 v_4 = RT_2$$

is found also to yield two similar equations—the whole occupying a full half page. Similarly, much space is taken up by writing down certain general equations in all the possible ways, as for example, the eight pages devoted to the fundamental equations of gases. This diffuseness cannot but distract the student from the continuous contemplation of the fundamental parts of the subject.

On the other hand, in the matter of illustrations, the author has advanced to a degree of simplification which is not only unnecessary, but is actually deceptive. It is surely not desirable to make the figures in an engineer's textbook so badly proportioned and with such an absolute lack of the sense of construction as in the diagrams of a throttling calorimeter, of a steam-engine indicator, and of an ammonia compression system. The author in his preface says that photographs are seldom, if ever, of any value. That is approximately true for machinery, but there is no need of replacing them with diagrams of such crudity.

In certain other respects, also, the value of the book is unnecessarily impaired. When there exists already a generally accepted nomenclature in any science, exceptionally good reasons must be advanced for any changes. In the section on internal combustion engines, the author speaks of four-cycle and two-cycle engines as "four-phase" and "two-phase" cycles, and explains in a footnote that the usual nomenclature is not "proper" since there are "four phases" to a cycle. His contention is wholly wrong, since four-cycle is merely an excellent contraction for four-stroke cycle, which is a perfectly good description of the cycle. Moreover, the word "phase" either as used in electrical engineering or in physical chemistry, does not mean a process, which is apparently the sense in which the author uses it. And to go still further, there are not four but six processes to the ideal four-stroke Otto cycle. Similarly, there is no excuse for calling the admission and exhaust strokes by such names as "aspirating" and "expulsion" strokes, or of inventing the term "commercial efficiency" for the ratio of the power delivered by an engine to the power which a perfect heat engine would deliver when working between the same temperature limits.

There is no tabulation of the properties of steam, but the old equation for the total heat of steam, which has now been superseded, has been retained. This leads to a notable inconsistency, since the author (p. 176) uses values for the total heat, which are taken from tables based on the newer equations, and consequently do not agree at all with his formula. Similarly, his equations for the adiabatic expansion of saturated steam can no longer be accepted.

The general purpose of the author, endeavoring to base the study of thermodynamics on a broader knowledge of the subject of heat, is in itself excellent; the book is generally accurate; the chapters on compression and refrigeration are more complete than is usual in works of this scope. Its value would be greatly increased by a compression of the material to occupy about two-thirds of the space.

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UNTERSUCHUNGEN AN DURCHLAUFENDEN EISENBETONKONSTRUKTIONEN—Von Prof. H. Scheit, Geh. Hofrat, Direktor der Kgl. Sachs. Mechan.-Technischen Versuchsanstalt in Dresden, and Dr.-Ing. E. Probst, Privatdozent an der Kgl. Technischen Hochschule in Berlin. Berlin: Verlag von Julius Springer. Paper; 8x11 in.; pp. 72; 52 text figures. Marks 5, net; American price, $2, net.

The authors made a serious and quite extensive attempt to bring some clearness into the much disputed question of how much continuity exists in reinforced-concrete beams extending over several panels. They made tests on beams continuous over from two to five panels, with spans of 3 m. (10 ft.), and for comparison also tested a simple span. The results of measurements under load indicate that the continuity which was realized was practically the same as is assumed in calculations based on uniform modulus of elasticity and uniform moment of inertia. One test of the series dealt with a continuous beam molded monolithic with supporting columns, and here (as was to be expected) the additional constraint due to the columns was clearly apparent.

UEBER NEUERE VERSUCHE MIT UMSCHNUERTEM BETON—(Spiralumwickelte und Ringbewehrte Säulen.) Von Dr.-Ing. A. Kleinlogel, Privatdozent an der Grossh. Technischen Hochschule in Darmstadt. Berlin: Wilhelm Ernst & Sohn. Paper; 7¼ x 10½; 25 text figures. Marks 3.20, net; American price, $1.28, net.

A new series of tests of hooped reinforced-concrete columns is reported in this pamphlet. They are compared with three or four prior sets of German column experiments and several conclusions are drawn. Most prominence is given to the conclusion that Considère's assumption of 50% excess strength of the concrete core of such a column is not justified, but that only the normal strength of the concrete is to be used in the formula. The results agree with other tests showing about 10% total equivalent reinforcement to be the most economical value.

A British quarterly called *Bedrock* (Constable & Co., London; 2½ shillings, net) makes its first appearance this month. It bears the subtitle, "A Quarterly Review of Scientific Thought." We note an article on "Interaction between Passing Ships," by A. H. Gibson, Professor of Engineering in the University of Dundee, one on "The Stars in Their Courses," one on Logic, several on Evolution and a book review department.

High Temperature Measurements

Reviewed by WILLIAM CAMPBELL*

THE MEASUREMENT OF HIGH TEMPERATURES—By G. K. Burgess, Bureau of Standards; and H. LeChatelier, Membre de l'Institut. Third edition, rewritten and enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. 510; 178 text figures. $4, net (17/- net).

The first edition of this book was based on the lectures of Professor LeChatelier at the Collège de France and appeared as "High Temperature Measurements," by LeChatelier and Boudouard, translated by Burgess. The present book has been rewritten by Burgess, for three classes of readers: "the student to whom the historical aspect and fundamental principles are of prime interest; the engineer who is interested mainly in adapting some method or instrument to his particular technical operation; and the investigator who has an intensive interest in accurate methods of measurement and their adaptability to his needs."

After a chapter on standard scale of temperatures in which are given the laws of Mariotte and Gay-Lussac and their application to the four types of gas thermometers, the author describes the standard gas thermometer. He sets forth briefly but clearly the work of Pouillet, Becquerel and other early experimenters, reviews the more recent work of Holborn and Day, Callendar and others, and ends with a short discussion of industrial air pyrometers. Calorimetric pyrometry is next taken up, including the Berthelot, the White and the Siemens instruments, precision of measurements and conditions of use.

The chapter on thermo-electric pyrometry is perhaps the most interesting. It starts with the experiments of Becquerel, Pouillett, Regnault, LeChatelier, and Carl Barus and describes the galvanometric and potentiometric methods and apparatus for the measurement of temperatures. Next comes electrical resistance pyrometry. The work of Siemens, Callendar and Griffiths, Holburn and Wien is reviewed and questions of construction, conditions of use and industrial installations are then taken up. In some lines of work, when the platinum can be protected from contamination and the temperature is not above 1100° C., such instruments as the Whipple or the Leeds and Northrup can hold their own against the thermocouple, for the hot end can now be made very small and the instrument reads direct, there being no correction for cold junction.

As an introduction to radiation pyrometers a chapter is devoted to the laws of radiation. This is followed by a review of early work and then modern apparatus is described, such as the Féry, Thwing, etc., and conditions of use and calibration discussed.

The next chapter deals with optical pyrometers. After a section on methods of temperature measurement the LeChatelier, Wanner, Holborn-Kulbaum, Morse and other instruments are well described. These two chapters are specially good and bring before us very clearly the advantages, applications and limits of modern optical and radiation pyrometers, which are rapidly becoming very important industrially.

After discussing various pyrometric methods, such as melting-point pyrometers, fusible cones, etc., an important chapter is devoted to recording pyrometers, in which subject great advances have been made. A final chapter on standardization of pyrometers deals with thermo-electric scales, fixed points, etc. The book closes with a bibliography of 24 pages and a number of tables.

A critical discussion of this book would be apt to lead to discussion of purely physical fundamentals which would be out of place here. To the student and to the engineer this work appeals for many reasons. In the first place it is clearly and logically written, and there is no tendency on the part of the authors to show off their learning, thereby leaving their readers far behind (as often occurs in specialized Physical and Physical-Chemical works); nay, rather it would seem that a great deal of trouble had been taken to reduce explanations to their simplest terms and this makes reading a pleasure rather than a strain. In the second place the practical application has been kept constantly in mind, the difficulties of use are emphasized, and the limits of the method indicated. The illustrations are well chosen and count much toward the excellence of the book, whilst the bibliography at the end of volume, though not exhaustive, contains the main references for each subdivision and will prove satisfactory to anyone wishing to consult original sources.

In conclusion, the authors are to be thanked for giving us such an excellent work at a time when it is most needed, for now the "practical man" has tried out the pyrometer and realizes that it is more trustworthy than the eye, in fact that it is a judicious investment. The binding, printing, paper, etc., are all excellent.

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A new technical monthly, *Western Engineering*, has appeared in San Francisco (420 Market St.), with C. T. Hutchinson, a mechanical engineer of that city, as editor. An opening editorial note states that the publication will be devoted to engineering work "in the West" and that it will be a "technical rather than a trade" journal. The first member contains a good variety of articles on civil, mechanical and electrical engineering, besides the digest, book, and various commercial departments. The page size is about 7x10 in.

ENGINEERING APPLICATIONS OF HIGHER MATHEMATICS—By V. Karapetoff. Part 1—Problems on Machine Design. First edition. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5⅛x8¼ in.; pp. 69; 17 text figures. 75c., net (3s. net).

In a very interesting preface the author explains that his book is intended as a means of teaching engineering students how to handle the calculus. The term "higher mathematics" in the title is to be taken, if we judge by the text of the book, as meaning the ordinary integrations and differentiations of calculus, and the preface does not indicate that the author means to go farther afield than this. We learn that the author believes that the ordinary way of teaching college mathematics does not fit the students properly for applying their mathematical knowledge practically, but that a practice book, such as he has written, should be used in the course of their instruction. After the preface, by the way, is inserted something radically novel: a dialogue between "Prospective User" of the book and the Author, in which the latter convinces the P. U. that the book is just what he needs.

The body of the book comprises six chapters dealing with the inclined plane, friction in journals, friction in step bearings, belts, shafts (torsion), and flywheels (moment of inertia). Each chapter consists of 10 to 20% explanation and 80 to 90% examples, many of which, however, include hints for their solution or other remarks which are in effect additions to the explanatory text. Evidently the book is to be used chiefly for its examples, and the student is supposed to work these out in order to secure the facility in applying calculus which the book is intended to teach.

The value of the book as an instrument for teaching would doubtless be estimated differently by different educators. From an outside standpoint we should be inclined to note: (1) That nearly every book on mechanics or similar engineering-theory subjects contains fully as many examples which exercise the student's facility in calculus as the present book; and (2) that the particular "engineering applications" which are discussed in this book are by no means of such practical importance or so neglected elsewhere in engineering instruction as to require a separate book dealing with them.

However, the book deserves to be taken on the author's intentions and his evident desire—a highly praiseworthy desire—to train engineering students up to a closer working acquaintance with their calculus than many college students seem to acquire.

Structural Engineering by Correspondence

Reviewed by ROBERT FLETCHER, Ph.D.*

THE ELEMENTS OF STRUCTURES—Prepared in the Extension Division of the University of Wisconsin. By Geo. A. Hool, S. B., Assistant Professor of Structural Engineering, The University of Wisconsin. New York and London: McGraw-Hill Book Co. Cloth; 6x9½ in.; pp. 188; almost 200 text illustrations. $1.75, net.

This treatise must be judged in view of the expressed intent of the author, who says: "This text has been developed solely with the idea of using it in correspondence study. It has been the aim of the writer to deal with the fundamentals in structural engineering in a simple and interesting manner and, as far as possible, to make the text speak to the student with a directness similar to that employed by an instructor to a student in residence." A knowledge of algebra, plane and solid geometry, logarithms, trigonometry, mechanical drawing and strength of materials is presupposed.

A brief examination of this work shows that the author has realized his expressed intention as successfully as could be expected for "this sort of thing." The subject matter is very clearly presented; the typography and the printing of the illustrations are unexceptionable, and the book is a convenient compendium.

As the reviewer has had no connection with correspondence schools, and no experience in dealing with the class of so called students who have to be dealt with by those who give instruction according to the methods of such institutions, he is probably not competent to appreciate fully the demand for such a work. His first thought is that a young man who has had as much preparation as is presupposed by the author should have something more than this compendium put into his hands; especially as more complete and excellent treatises on the theory of framed structures have been published by distinguished professors connected with the University of Wisconsin. The treatment of such comprehensive subjects as loads on structures, principles of statics, reactions, shear and moment, influence lines, concentrated load systems (treated algebraically and graphically) stresses in truss members, design of structural members, use of steel handbooks, and the structural shop is necessarily very brief in each case—the shortest chapter, on influence lines, covering less than six pages, and the longest one, on use of the steel handbooks, covering 34 pages. To one who has taught the subject to regular classes for many years such brief and condensed presentation of topics so large, and needing so much amplification, does not seem to be sufficient to give a proper mastery of the subject by any grade of students. The most that can be said is that it gives the young men a good start in the right direction. The justification for such a work must, of course, be determined by the law of demand. The reviewer must believe that the demand should be for something larger and more complete.

A minor defect in Fig. 3a deserves notice: the purlins of the roof truss are represented as very thin and flat and placed flat-wise. Here the drawings should represent the member not merely conventionally, but in actual proportions. The same may be said of the isometric drawing on page 7, where the details of connections and the super-position of members are not properly shown. But usually the figures are neatly drawn, suggestive, and adequate for the purpose.

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An Elementary Text on the Business Side of Engineering

WORKS MANAGEMENT. By William Duane Ennis, M. E., M. Am. Soc. M. E.; Professor of Mechanical Engineering in the Polytechnic Institute of Brooklyn. New York and London: McGraw-Hill Book Co. Cloth; 6x9½ in.; pp. 194; many text illustrations. $2, net.

Ever since A. C. Humphrey became president of Stevens Institute of Technology, we have heard much of the necessity of instructing engineering students in the business features of their work.

President Humphrey's lectures to his students on business topics were first published in 1905 and have considerably influenced engineering instruction in this country, although at first a feeling was evident in some quarters that it was unprofessional to associate commercial questions with engineering. We believe that now in all the leading technical schools some attempt is made to present the economic aspects of engineering work as well as to give an insight into the character of design and quality of construction. The wider recognition by engineers of the benefits secured from the scrutiny of production costs, fixed charges, overhead burdens, depreciation, etc., has been followed with a realization by executive officers of the equally great benefits that could be secured by the injection of engineering methods into their business operations. This combination of engineering and economics has yielded such remarkable results that it is little wonder that "efficiency engineers" are springing up from all sides and that some of them are clouding the issue by vociferous and extravagant claims.

Prof. Ennis is not one of the class just indicated. His book is a useful manual for the young mechanical engineer, or for any engineer who has had little contact with the business side of engineering and manufacturing. It contains about what would be expected in a series of lectures to college students. There is first a discussion of the significance of cost data, and of cost-record keeping and use. Then comes a discussion of labor-cost apportionment, the compensation of labor and bonus systems for extra attainment. The common systems for the purchase, use and protection of raw-material stores are explained, after which there is a discussion of the distribution of general expense burdens and depreciation of plant over the product. After this, there are outlined the ways of organizing an enterprise and the elementary principles of accounting. Rules for the design and layout of a physical plant are given, so far as they can be very broadly and briefly stated in the absence of a specific case.

The subject matter has been reduced to the simplest and most elementary forms. Few specific illustrations of methods are given. There is a conspicuous absence of the details of card systems with which other writers are prone to load us.

Comparison will naturally be made first of this book with its early predecessor, President Humphrey's "Lecture Notes on Business Features of Engineering Practice." Prof. Ennis pays much less attention to accounting and goes less into detail in such matters as depreciation, but he secures probably a better rounded and more inclusive survey of the economic features of organization and production for industries which convert raw material into manufactured articles through the application of labor and machinery.

There is also a wide difference between this book and Prof. Hugo Diemer's "Factory Organization and Administration." This difference springs largely from the greater inclusiveness of the book under review as well as the author's effort to strip away details. Prof. Diemer, it will be recalled, discusses the economic location of the factory, the organization of officers and men and then devotes his efforts to describing and picturing actual inter-department reports on orders, purchases, materials, labor-hours, wages, production and cost. A comparison of the two books will show that Prof. Ennis has actually gone closer to the economic heart of things industrial, a fact which seems to render his book more valuable for the first opening up of the subject to a student. No doubt even in Prof. Diemer's classes, the use of the material in his book would be preceded by some very general lectures, covering much of the ground of Prof. Ennis' book.

Prof. J. C. Duncan has a book, "Principles of Industrial Management," somewhat on the same lines, so far as goes the treatment of organization, labor and records, but less than half of the book is given to those three general topics, the rest being devoted to a rather historical exposition of geographical location, business consolidation and organization.

If there is any criticism that can be made of Prof. Ennis' book as a whole, it is that the author has not laid stress enough on the wide application and utility of standards—possible attainments by which actual costs may be judged, or by which actual quantities and qualities may be compared. The sequence of topics may not suit all and there will doubtless prove to be some difference of opinion about a few details positively stated. But it will be universally admitted that the author has made a simple and convincing statement of the need of complete organization and of approximately finding the true cost of a manufactured article. Aiding the student to realize these truths is a distinct benefit to him and to the engineering profession.

Ship Hull Construction

Reviewed by D. W. TAYLOR*

CONSTRUCTION NAVALES—Coque. Par J. Rougé, Ingénieur Principal de la Marine. Paris: Octave Doin Et Fils, Editeurs (8, Place de l'Odéon). Cloth; 4¾x7¼ in.; pp. 303; 129 text figures. Francs 5, net; American price, $1.50, net.

This volume is a part of a mammoth scientific cyclopedia being published in France. This cyclopedia is divided into 40 sections, or libraries, and will contain in all about a thousand volumes, averaging some four hundred 5x7-in. pages each.

The section including the book before us deals with applied mechanics and engineering and will contain 72 volumes, of which 32 have been published. The sub-head "Art Naval" will comprise nine volumes.

The present volume deals only with the construction of the hull and its appendages. There will be a separate volume dealing with fittings or accessories and also separate volumes dealing with marine engines and boilers.

The principal subjects treated are the materials of construction and methods of assembling and connecting them, the stresses and strains upon hulls, the considerations determining the scantlings and methods of assembling the principal members and parts of wooden and iron hulls, and finally appendages of the hull proper, such as masts, machinery foundations, docking and bilge keels, and for men-of-war the hull constructions in connection with armament and armor.

Considered as that portion of a cyclopedia which deals with hull construction this is an excellent book. It gives in a condensed form a great deal of well arranged information as to what is done in hull construction and in many cases takes up adequately the question of why certain things are done. It deals succinctly and satisfactorily with the history of many developments during the last 50 or 60 years, such as protection of men-of-war by armor and the supplanting of wood as the main material for shipbuilding first by iron and then by steel.

As a working reference book for any one engaged in designing or constructing hulls it is of comparatively little value for the reason that it gives little information in detail as to how things are done and a large part of the information given deals with wooden ships and vessels of ancient type.

While there are numerous figures, they are on such a small scale that they cannot be regarded as more than sketches, and very few of them illustrate most recent or present practice as regards either merchant or war-ship construction.

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A Layman's Public Hygiene

PUBLIC HYGIENE—By Thos. S. Blair, M. D., Neurologist, Harrisburg, Penn., Hospital; Author of "A Practitioner's Handbook of Materia Medica," "A Practitioner's Handbook of Modern Medical Treatment," etc. Assisted by numerous contributors. In two volumes. Boston, Mass.: Richard G. Badger, The Gorham Press. Cloth; 6¼x9½ in.; pp. 644; 158 text figures. $10 per set, net; expressage 50c. extra.

These two closely printed volumes contain a mass of information on public hygiene. The work, however, is written almost wholly by practicing physicians and is intended for the same class. In neither plan nor execution does it show a firm, comprehensive grasp of the principles of public hygiene, much less of sanitary science, in so far as the two can be distinguished. The chief value of the work lies in its collection of extracts from statutes, ordinance, rules, educational circulars and record blanks of state and local boards of health, and its digest of other scattered matter showing current practice. Both the author-editor and his contributors show a surprising ignorance or ignoring of the standard literature of many of the subjects treated in the book.

Since the book was avowedly written, or written and edited, by a doctor for doctors, it is only fair to say that it contains much that if read and profited by would enlighten the dark ignorance of most physicians on public hygiene—and not a little that would lead or keep them in darkness. While information of the same sort, generally presented with greater scientific accuracy and fullness, is readily available elsewhere it may be that the mass of practicing physicians will take more kindly to a volume like this, written by a professional brother, who, like themselves, is a layman in public hygiene.

Among the many topics treated are the family in its relation to the community, various classes of public and semi-public buildings and institutions, rural hygiene and sanitation, home hygiene and interior sanitary installations, federal state and local health-protective agencies, army and navy hygiene and sanitation, various phases of the control of communicable diseases, foods and drugs, laboratory methods, public carriers and quarantine and public works and corporations. Under the last named topics water supply, sewage and garbage disposal are considered—also oil pipe lines, mine dangers and factories and workshops. Water-supply, sewage and garbage disposal might have been treated much more adequately, even within the little space given them. Some of the statements made are amusing, though not so intended; others are absurd. It is not easy to see why the author, in another chapter, got Wm. G. Snow to write of heating and ventilation, but considered himself quite competent to handle the equally technical subjects, water supply and sewage disposal.

Nearly all the many illustrations are well presented halftone views, but of no special value except for their pictorial interest.

While the author deserves commendation for his diligence and good intentions it really seems a pity that so much of both should have been used and so much money expended on composition, engravings, paper, presswork and binding to traverse again a field most of which has been covered again and again with better net results. Had the author consulted the many existing books on public hygiene and sanitation—municipal, institutional, rural and domestic—he might then have presented, in relatively few pages, his own conclusions in the way of agreement, disagreement and interpretation for the benefit of less informed members of the medical profession. A well chosen classified weighted or critical bibliography might have been inserted for those who wished references to authorities. If he thought it worth while, the author might then have appended a hundred pages or so of statutes, ordinances, rules and blank forms for the benefit of the few practicing physicians who are likely to care for them. The resulting small and inexpensive volume might then have had ten purchasers and a hundred readers to every one who buys and reads this large, discursive and costly two-volume work.

STATISCHE TABELLEN — Belastungsangaben und Formeln zur Aufstellung von Berechnungen für Baukonstrucktionen. Gesammelt und Berechnet von Franz Boerner. Berlin: Wilhelm Ernst & Sohn. Cloth; 4¾x7¼ in.; pp. 259; 357 text figures. Marks 4.20, net; American price, $1.68, net.

Structural engineers' handbooks exist in a variety of different forms. This German handbook may be described as a combination of a rolling-mill handbook and Osborn's Tables. Since it relates to German rolled shapes, it cannot prove of much direct service to American designers. However, there is much information in it concerning official regulations, building laws, etc., and there is also matter on formulas and other data which the

engineers may have use for. As an accurate record of foreign practice, the book might well find place on the structural engineer's book-shelf, even though he would never find use for its tables.

Reinforced Concrete

REINFORCED CONCRETE CONSTRUCTION IN THEORY AND PRACTICE—An Elementary Manual for Students and Others. By Henry Adams, M. Inst. C. E., M. I. Mech. E., F. S. I., F. R. San. I., etc.; Member of the Council of the Concrete Institute; late Professor of Engineering at the City of London College, and Ernest R. Matthews, Assoc. M. Inst. C. E., F. R. S. (Ed.), F. R. San. I., F. G. S.; Member of the Concrete Institute; Borough Engineer and Surveyor of Bridlington. New York and London: Longmans, Green & Co. Cloth; 6x9 in.; pp. 316; 324 text illustrations. $3, net.

In our mind's eye we sometimes see the ideal text on reinforced concrete. With it as a guide the merest tyro will be able to trace his way from the most elementary facts of material and design to a knowledge competent to attack those problems of construction that only building experience can present. With it as his desk companion the experienced engineer will have at hand all the standards of strength and stress and the typical examples of various structures that are so necessary for his practice, but which needlessly tax his memory. It will be a judicious combination of Turneaure and Maurer's theory, Taylor and Thompson's infinite detail, Buel and Hill's and Reid's examples of structures, Heidenreich's compactness, and Talbot's and Mörsch's tests. Last of all, though it taxes our visionary ability to its limit, it will show us how to figure a flat-floor-slab system to the common satisfaction of C. A. P. Turner and the Joint Committee.

We mention this ideal here merely because Messrs. Adams and Matthews have fallen so far short of it. According to the title and the preface their book is an elementary treatise, so possibly it is hardly fair that it be compared to a composite ideal, but even considering its intention the result is far from successful. On the mere strength of personality this should not have been so. The authors are both distinguished engineers. One of them, at least, has an enviable record of authorship covering many fields, and the other's name has frequently appeared as the writer of papers for technical societies on both sides of the Atlantic. Their knowledge of the subject of reinforced concrete cannot for a moment be doubted and their experience in its practice has been of the widest. In spite of this their book is surpassed by many of the volumes comprising the voluminous literature of reinforced concrete, and in fact has no good reason for existence other than to exploit the names of its authors.

The first chapter is the usual one, briefly stating the history of reinforced concrete and discussing the properties of the materials that make it up. This discussion of properties is very limited in its information and verbose in its stating. Among other things, we read that in America natural cement has been used very considerably for reinforced concrete and that if concrete work is to be watertight, gravel concrete has the advantage over broken stone. This will be news to American engineers at least. The chapter is as good as those found in most elementary treatises, except for the fact that nowhere is reinforced concrete defined or is the reason for the steel explained or its position in the structure dealt with. Chapter II, "General Principles of Stress," takes up in very complete manner the elementary theory of the stresses in a beam. The mathematics has been reduced to the lowest terms and the treatment is all that could be expected. Chapter III applies the theory of stress to reinforced concrete, but here again we find the remarkable absence of any discussion of the nature of a reinforced-concrete beam or column. The authors seem to assume that the reader already understands what a reinforced-concrete beam is and how the concrete is reinforced. In the discussion of columns particularly this absence is to be noted, for although "hooping" is mentioned several times, nowhere is there any statement as to what "hooping" is, or what its function is supposed to be.

Chapter IV leaps into the middle of typical examples showing the design of simple beams. The examples are worked out by simplest arithmetic and apply very well to the most elementary forms, but no statement is made as to how these forms enter into a structure, nor is there any suggestion that there may be variations in the method of applying the reinforcement. Chapter V, entitled "Special Construction," shows several designs of retaining walls, bins, chimneys and arches. The discussion of the first three is the usual one, but the portion on arches is quite useless on account of the very short space which is given to it, and the recurrence of the curious combination of an assumption of knowledge and ignorance on the part of the reader. Chapter VI returns to the question of material and discusses the effect of heat and frost on concrete in a limited fashion. In the middle of the chapter there has been inserted more material concerning the design of chimneys.

By a peculiar mischance, in the copy that has come to us at least, Chapter VII is headed "Reciprocation, Duality, Abridged Notation and Projection," and these sonorous words are repeated in the table of contents and as page headings, though the chapter which they lead seems to be devoted to descriptions of various concrete structures in no way meriting such distinguished nomenclature. This chapter and the two following are given over to the description of various structures built of concrete, mostly short categorical descriptions overbalanced with unnecessary dimensions and credits to engineers and contractors. References are numerous to the cuts, which have appended to them merely a figure number with no descriptive caption. The reasons for peculiarity for the design of any of these structures or the noteworthy features of them are omitted. The last chapter, headed "General Notes," is made up of scattered information on various subjects forgotten in the remainder of the book.

Throughout the book the drawings and photographs are much too numerous, especially as the halftone reproductions rarely show anything of the details of the structure and the line-cuts are so reduced and deleted of lettering as to make them of little value. Furthermore, most of the structures illustrated are not uptodate, which shows the danger in allowing a book to usurp the function of the periodical press. In fact, the last two paragraphs of the critical article from the London *Times*, reprinted on p. 754 of this issue, so aptly apply to this book that we again print them below as a specific application rather than a glittering generality:

> To come to the faults of the technical books which are now appearing so rapidly, many of them are badly written, badly arranged and badly priced. Many authors do not appear to have in mind any definite purpose for their books. They do not seem to take the trouble to ascertain if such a book as they contemplate is really needed. They do not ascertain, before beginning their task, how far the field is already covered—in which respect they are like too many inventors. They often take no trouble about the general appearance of the pages.
>
> A book on the elementary portions of a subject is, of all, the most difficult to write. It is so easy to leave out the essentials and to include the superfluous. In general, it may be said that, in a book for students, reproductions of photographs are unnecessary. What is required are line diagrams. These need to be carefully thought out and skillfully arranged. They should be drawn by a practised hand.

ELECTRIC CRANES: THEIR DESIGN, CONSTRUCTION AND APPLICATION—Being Vol. 1 of a Complete Manual on Lifting and Hauling Machinery. By H. H. Broughton, A. M. Inst. M. E., A. M. Inst. E. E., A. Am. Inst. E. E., Whitworth Exhibitioner, Head of the Electrical Engineering Department and Lecturer on Machine Design and Structure at the Municipal Technical College, Brighton. London: "The Electrician" Printing and Publishing Co., Ltd. (New York: D. Van Nostrand Co.) Cloth; 6x9½ in.; pp. 812; 581 text illustrations; 115 tables. 25s. net; American price, $9, net.

Eight hundred pages on electric cranes represent a great amount of matter. Much of the contents consists of description of particular cranes and crane installation. We miss a classification of cranes either as to structural arrangement or as to service, a matter which is more or less badly needed in crane practice. Those parts of the volume which deal with crane motors and with the analysis of crane structures are likely to prove least useful to the crane designer or user. The

descriptive matter on brakes, switches and actually built cranes is the principal element of value of the work.

Practical Information on Stamp Milling

Reviewed by F. W. TRAPHAGEN*

STAMP MILLING—A Treatise on Practical Stamp Milling and Stamp Mill Construction. By Algernon Del Mar, Assoc. Royal School of Mines of London; M. Am. Inst. Mining Engineers. New York and London: McGraw-Hill Book Co. Cloth; 6x9½ in.; pp. 134; 98 illustrations in text. $2, net.

Mr. Del Mar has had a wide experience in the field he covers in this book, and as he is a keen observer, he has incorporated within the 134 pages of text a great deal of valuable information covering the best practice in the field.

The subject is considered under seven heads: Evolution of the Gravity Stamp Mill, General Principles, Practical Working, Limitations of the Single Unit and Five-stamp Unit Batteries, History of Amalgamation, Amalgamation, and Stamp Mill Construction.

Directions are given in sufficient detail to enable the ordinary mill man to meet the various conditions usually confronting him. The many difficulties encountered in mill practice are discussed and remedies suggested.

The stamp mill, despite the constant appearance of new crushing devices, continues to hold its place, and recently in South African practice has entered a new field, that occupied by rolls and other intermediate crushing machines. How long this supremacy will be maintained is a matter of conjecture; certainly, however, as a means for preparing gold ore for amalgamation, stamps will be used for many years to come.

The advent of the new type of ball mill with plain chrome-steel liners and chrome-steel balls, marks the appearance of a powerful adversary in the field of intermediate crushing, and even for finer crushing up to the point where the tube mill reigns supreme. The simplicity of this new ball mill, together with low repair costs, indicates a new departure of milling practice in which the field of crushing rolls, as well as of stamps, is likely to be the scene of a sharp competition, with the probable result of a complete revolution in our present practice.

In the chapter on amalgamation are a number of statements that can hardly be passed without a challenge. The freezing point of mercury is given at "—39° F. or —40° C." Distilled mercury is stated to carry "under ordinary conditions about 0.1 per cent. gold." "Most electric processes use sodium chloride, assuming that an electric current will set chlorine free. This is a fallacy, for chlorine cannot be free (sic) from salt by an electric current unless the salt is perfectly dry." If this be true how do such salt cells as the Townsend, for example, produce chlorine at a commercial rate from solution?

Mr. Del Mar's book is certain to find a favorable reception among those who have to do with stamp milling and contains much matter that cannot fail to be of the highest value.

The book is written in non-technical language and can be used to advantage by the college-trained man as well as the man who has not had such training.

Marked carelessness is evident in the use of the King's English, for the book is full of ungrammatical and involved sentences, showing that it was not carefully edited; the author probably prepared his material under pressure and lacked sufficient time to look it over afterward.

Unlike the other books from the publishers of this volume, this one is full of typographical errors, most of them so evident that one wonders if the proofreader were awake when he read proof.

Notwithstanding the above faults the book is a good one, and will prove of considerable value to those for whom it was written.

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The Railways and the Public

THE AMERICAN TRANSPORTATION QUESTION—By Samuel O. Dunn, Editor of "The Railway Age Gazette"; Lecturer on Transportation at Northwestern University; Member of the Illinois Bar. New York and London: D. Appleton & Co. Cloth; 5x7½ in.; pp. 290. $1.50, net.

A more descriptive title for this book would have been, "The Relations between the Railways and the Public." The transportation question to which the book is chiefly devoted is the question how far the public shall go in its control of the railway business. The author emphasizes the fact that the public is as much concerned in the kind of service given by the railways as it is in the rates to be charged. He recognizes that public regulation is here to stay, but urges that if it is to be effective for the public welfare, it must be carried on with greater intelligence in the future.

The opening chapters of the book discuss the principles of railway rate making, comparing the "cost of service" and "value of service" principles. Then come two chapters on railway discrimination, two more on railway valuation and two on railway efficiency. Two chapters of especial interest to engineers discuss the economics of rail and water transportation. The concluding chapters discuss government regulation.

The book is not an "exhaustive treatise," but is a concise and intelligent discussion which may be studied with great profit by everyone interested in the important problem of railway regulation.

There is no doubt that we must make the experiment of public regulation on which we are engaged successful, or we shall be forced to adopt government ownership and operation with its attendant difficulties and complications. It is a real public service to present the facts regarding railway regulation in such clear and forcible style, and we trust Mr. Dunn's book may have a wide circulation.

APPLICATIONS OF REINFORCED CONCRETE—Eisenbahnbau, Tunnelbau, Stadt- und Untergrundbahnen, Bergbau. Part VII of "Handbuch für Eisenbetonbau." Second edition, enlarged. Herausgegeben von Dr. Ing. F. von Emperger, K. K. Oberbaurat, Regierungsrat im K. K. Patentamt in Wien. Written by E. Homann, J. Labes, R. Basteau, A. Nowak, B. Nast. Berlin: Wilhelm Ernst & Sohn. Paper; 7¼x10½ in.; pp. 511; 1093 text illustrations. Marks 21; cloth, M. 24; American price, $8.40 and $9.60, net.

This is one of twelve volumes intended to cover the field of reinforced-concrete construction. The first edition consisted of four volumes, but for the second edition a far more extensive plan has been adopted. The present is the fifth volume of the set to be published; a sixth is expected to come out during the year.

The book includes reinforced concrete in railway, municipal and mining work. It describes and illustrates a large number of structures in these several classes, chiefly by drawing, and this descriptive element constitutes the chief element of value of the book. Naturally most of the examples are from European practice. A larger amount of material can be covered, of course, than in the ordinary single-volume work on reinforced concrete; the reader will therefore find the book to present an unusually full and varied assortment of structures. The names of most of the section authors are well known in the art, and assure satisfactory treatment.

TABLES OF PHYSICAL AND CHEMICAL CONSTANTS AND SOME MATHEMATICAL FUNCTIONS—By G. W. C. Kaye, B. A. (Cantab.), D. Sc. (Lond.), A.R.C. Sc. (Lond.); The National Physical Laboratory; Late Sub-Lector in Physics, Trinity College, Cambridge, and T. H. Laby, B. A. (Cantab.); Professor of Physics, Wellington, N. Z., formerly Exhibition of 1851 Scholar; Joule Student; and Research Exhibitioner, Emmanuel College, Cambridge. London, New York, Bombay and Calcutta: Longmans, Green & Co. Linen; 6½ x9¾ in.; pp. 153. $1.50, net.

A great variety of data are found between the covers of this book. The authors have ranged over the fields of heat, light, sound, electricity, magnetism, and physics and chemistry generally; more than this, they have dipped just a bit across the borders into engineering, astronomy and geology, though not deeply. It is not possible to state very definitely where the greatest uses of this volume may be made, since the subjects included have a wide range. Certainly, it seems adapted for use in connection

with a very great variety of laboratory investigations and doubtless the authors so intended it. Their standing as physicists should guarantee the accuracy of the pages—barring incidental typographical errors; their experience in research should make the book a time saver.

Hydraulic Formulas and Tables

Reviewed by JOHN H. GREGORY*

THE PRECISE AND THEREFORE ECONOMIC CALCULATION OF PIPE DRAIN AND SEWER DIMENSIONS FOR USE IN WATER SUPPLY, DRAINAGE, etc.—By C. E. Housden, Late Superintending Engineer, Public Works Department, India; and Sanitary Engineer to the Governments of Burma and Eastern Bengal and Assam. New York, London, Bombay and Calcutta: Longmans, Green & Co. Cloth; 5x7½ in.; pp. 53; illustrated. $1, net.

In this small book of 53 pages the author has undertaken to present a few formulas and a short series of hydraulic tables to assist the engineer to ". . . rapidly, confidently and accurately ascertain the safe minimum dimensions . . . of pipes, drains and sewers . . ." The sections considered are the circular, three types of egg-shaped and the open trapezoidal with various side slopes. The tables for use in determining the size of these sections are, so the author states, based on ". . . generally accepted coefficients used by Kutter, Unwin, Fanning, Bazin, etc."

If no other book or set of hydraulic tables was at hand the engineer could make use of the formulas and tables given, but unfortunately the author has not presented the matter in a clear concise form such as would appeal to the busy engineer. Some of the tables are so arranged that an impression of doubt is left as to whether they have been used correctly or not. About one-half of the tables are printed so as to be read from the side of the page and therefore cannot be used as rapidly in conjunction with the text as if printed so as to be read from the bottom of the page.

NATIONAL CONSERVATION CONGRESS—Proceedings of the Third [Congress] at Kansas City, Mo., Sept. 25-27, 1911. Kansas City, Mo.: The Congress (John B. White, President). Paper; 6x9¼ in.; pp. 319; illustrated. $1, net. ($3 per set of three—1909-1910-1911—net.)

The participants in this Congress included a considerable number of well known engineers. One of the subjects which received much attention was the question of improving conditions in the rural districts, so as to stop the migration from the farms to the city. It is essential to the proper conservation of the soil resources that the men who till the soil shall not undergo deterioration.

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Elementary Graphic Statics

Reviewed by ROBERT FLETCHER*

ELEMENTARY GRAPHIC STATICS—By W. J. Crawford, D. Sc., Lecturer in Mechanical Engineering, the Municipal Technical Institute, Belfast. London: Charles Griffin & Co., Ltd. Philadelphia, Penn.: J. B. Lippincott Co. Cloth; 5¼x8 in.; pp. 131; 111 text illustrations. $1, net.

This little book is certainly elementary, as the title states. The author develops the subject by an introduction giving the usual definitions of force, line of action, resultant, "equilibrant," etc. He then endeavors to demonstrate the principles of the parallelogram of forces and equilibrium by describing experiments with models using pulleys, weights, springs, bars and frame work to reproduce the conditions of action of derricks, the funicular polyon, etc.

For a certain grade of students who have had no training in mechanics or in the study of mathematics the book may be useful. To an American teacher accustomed to dealing with students who have had sufficient mental training to be able to master elementary mathematics and mechanics the aim of the author seems to be misdirected. He says: "The subject is very important to all engaged in engineering, building construction, and allied professions, for not only does it offer solutions to many common everyday working problems, but it dispenses to a large extent with the use of mathematics." Why should a teacher of engineering deliberately set out to write a book of this kind and try to avoid "to a large extent the use of mathematics," in the very subjects where mathematics especially and most usefully finds application?

The method of demonstrating by aid of described models and apparatus is certainly not suitable for giving a real grasp of the subject. Students having such limited preparation as to need such an elementary text-book would be most apt to be misled, by inferring that the proof of the essential principles requires the use of such mechanical contrivances; whereas these are only aids for rather crude and approximate verification and illustration of theorems which must be demonstrated first by mental process. The pure theory is such a simple application of elementary geometry that it could be grasped by a properly interested student without such aids.

On the last 15 pages are given 90 examples, the usual elementary problems relating to forces, moments, beams, center of gravity, etc., such as are commonly found in elementary treatises on graphic statics and applied mechanics. There is so much more that the student should know that it is difficult for an American teacher to find a place for this book unless it be in a night school or in a correspondence school where students not well prepared have only a limited amount of time to devote to the subject. However, for a certain grade of students who must be content with an introductory course, the book is excellent and well adapted, if they are cautioned that proof is not dependent upon mechanical aids. It is a handy book, very well printed; the figures are neat, and there are six halftone prints of the models used for experiment and illustration.

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HIGHWAY ENGINEERING—As Presented at the Second International Road Congress, Brussels, 1910. By Arthur H. Blanchard, C. E., A. M., Consulting Highway Engineer, and Henry B. Drowne, C. E., Professor and Instructor (respectively) in Highway Engineering, Columbia University, New York City. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; pp. 309. $2, net.

Professors Blanchard and Drowne have rendered a distinct service by condensing the proceedings of this Congress so as to bring them within the time and purse of any person who has even a moderate interest in the subject. Various phases of the construction and maintenance of urban and rural highways, including roads and pavements, dust prevention, special trackways, street railways, and sidewalks are presented in the form of statements by "reporters" for the various countries represented at the Congress, or discussions of such reports. The reports are classified by subjects. There is also an account of the Congress as a whole and a full reprint of the "Conclusions" adopted. Both an author and a subject index add to the value of the book, which is an epitome of a considerable body of road and pavement practice and opinion in the leading countries of the Eastern Hemisphere.

RETAINING-WALLS FOR EARTH—Including the Theory of Earth-Pressure as Developed from the Ellipse of Stress. With a short treatise on Foundations, illustrated with examples from practice. By Malverd A. Howe, C. E., Professor of Civil Engineering, Rose Polytechnic Institute; M. Am. Soc. C. E. Fifth edition, revised and enlarged. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5x7½ in.; pp. 181; many illustrations in text. $1.25, net.

The revisions in this fifth edition of Prof. Howe's standard work on retaining walls consist mainly in corrections in the notation of the section on reinforced concrete so that it conforms to standard practice, and the addition of a large number of profiles of walls already built. With these additions the book now comprises a complete treatment of the theory of earth pressure against walls, as originated by Weyrauch, with simplified formulas to cover all cases of loading, an application of this theory to the design of walls of various shapes, a discussion of foundations for walls with descriptions of the different types, numerous drawings of wall sections and supplementary tables of mathematical constants.

Paints and Paint Tests

Reviewed by ROBERT JOB*

PAINT TECHNOLOGY AND TESTS—By Henry A. Gardner, Assistant Director, The Institute of Industrial Research, Washington, D. C.; Director, Scientific Section, Paint Manufacturers' Association of the United States, etc. New York and London: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. 266; many illustrations. $3, net.

This book is essentially a summary of important work carried on in recent years by the Paint Manufacturers' Association of the United States, particularly with reference to exposure tests made under widely differing climatic conditions to determine the relative service values of various pigments. In addition there is much useful general information regarding paint materials and practice.

The properties of the principal oils and thinners used in paint manufacture are stated in the first chapter with the characteristic effect of each upon the paint film.

A chapter is devoted to a study of driers and their effect. It contains the results of a series of tests of various compositions, particularly of lead and of manganese, and a statement as to the proportions found in practice most effective in producing drying throughout the film. Tables also show in detail the rate of drying of the principal paint oils.

Under Paint Pigments and their Properties numerous photomicrographs indicate the characteristic appearance of many of the important pigments. In general these illustrations are clear and give a good idea of the materials, but unfortunately the magnification often is not mentioned, so that one unfamiliar with these matters would be unable to make comparison of the relative size of the particles. The description of the principal properties of the pigments usually gives the essentials, though in the paragraph on Lithopone no mention is made of its property of darkening where the paint is not exposed to good light.

The importance of the study of paint films is well known, especially in connection with the porosity which is known to exist in linseed oil, and various types of apparatus are shown which have been devised to measure the relative porosity of oil, paint and varnish films. No results of very immediate practical benefit seem to have resulted from this study, though the fact which has long been known by practical painters that porosity of a film varies largely with the pigments used and with their physical condition.

A great deal of public interest has been aroused in recent years by the experimental work of the Paint Manufacturers' Association of the United States, and particularly by the tests of pigments at Atlantic City, Pittsburg, North Dakota and elsewhere, the results of which were published originally in bulletins by the association and are now in part reproduced by Mr. Gardner. From these data one can find out for himself which pigments are best adapted for service under different conditions, and also which mixtures have been found generally most efficient both upon wood and upon metal, while the characteristic mode of failure of some of the pigments is also clearly reproduced.

The book should be of decided help both to the practical painter and to the technical paint student.

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PREVENTION OF RAILROAD ACCIDENTS—Or, Safety in Railroading. A Heart to Heart Talk with Employees. By Geo. Bradshaw. New York: The Norman W. Henley Publishing Co. Stiff paper; 4½x6½ in.; pp. 173; 22 text figures. 50c., net.

It is the aim of this booklet to eliminate neglect and carelessness on the part of railway employees. The author enumerates as three chief causes of railway accidents the neglect of little things, taking chances and violating rules and instructions. These three prolific causes of accidents, he states, cannot be eradicated by law nor by the rules and regulations of the company. Their origin is in the personality of the employee and their prevention must come from the same source. The author appeals to railway men to make the matter a personal question and to take upon themselves the duty of not only themselves observing all due precautions, but seeing to it that their fellow employees do the same.

There is a tendency among railway men, according to the author, to give too little importance to accidents involving personal injury to fellow employees. He states, for example, that if an experienced engine man should burn a boiler and allow a crown sheet to drop he would be disgraced among his fellow employees, but if, on the other hand, he had run over and killed a brakeman through failing to sound the required signals or through some other act of carelessness he would not have been blamed.

Another bad tendency cited on the part of some railway employees is that of using their own judgment as to the necessity and advisability of complying with positive rules. One of the several examples given by the author is as follows:

> Not long ago I happened to be standing beside a piece of new track where a speed-limit board positively directed that speed on that track be reduced to 20 miles per hour. While I stood there, a passenger train passed running at fully 40 miles per hour. Now, the division engineer who had charge of that track had had his professional training and experience, and he knew just how much speed was safe on that track. Yet the engine man of that train, with no professional training and no track experience whatever, laughed at that board placed there to protect the lives of himself and passengers, called the division engineer a fool, and ran according to his idea of what was safe and proper.

The book opens with statistics of accidents to railway employees and some discussion of safety appliances. The author states that no safety appliance is safe in the hands of an unsafe man. Next comes a general discussion of the part played by negligence and disobedience in railway accidents. The central section of the book is occupied by a number of photographs showing the unsafe and safe ways of doing things on train and track. One section is devoted to the handling and loading of explosives and one to safety devices for railway machine shops. The book closes with a classified list of safety maxims for railway employees.

MODERN AMERICAN TELEPHONY—In All Its Branches. Edited by Arthur Bessey Smith, E. E. Chicago, Ill.: Frederick J. Drake & Co. Stiff morocco; 4½x7 in.; pp. 790; 470 text illustrations. $2, net.

The author of this book has evidently attempted to give the telephone-plant workman in any one branch of such work a knowledge of the equipment used in all other branches. In this he seems to have secured considerable success, but his attempts to explain in popular terms the fundamental electrical phenomena on which the science of telephony is based are not so well executed; this general matter, however, covers about one-seventh the total volume. The confusion that the author here sows is well illustrated by the opening sentence of Chapter IV:

> The electrical current in its practical applications may be described as a force which is derived from and readily converted into other forms of energy, and by means of which the transmission of energy is effected more readily than by direct application of power.

Most of the book, fortunately, is not confusing. We find useful descriptions in detail of the different pieces of apparatus for the magneto, common-battery and automatic systems. Particular attention is paid to switchboards, rural lines, underground construction, etc., and there is a short general summary of wireless telephony development.

NATIONAL ASSOCIATION OF CEMENT USERS—Proceedings of the Seventh Annual Convention, Held at New York, N. Y., Dec. 12-20, 1910. Vol. VII. Edited by the President (Richard L. Humphrey). Philadelphia, Penn.: The Association (E. E. Krauss, Secy.). Cloth; 6x9¼ in.; pp. 920; many text illustrations.

The latest Proceedings of the National Association of Cement Users contains the minutes of the Seventh Annual Convention held in December, 1910, in New York City. For the first time in the history of the Association, the Proceedings are bound in boards which, with the admirable typographical work, adds considerably to the purely physical value of the volume. The meetings of this Association extend over an entire week, and embrace from 10 to 15 regular sessions. Needless to say, the amount of work transacted is very large and the material presented of

considerable value to the users of cement and concrete. The papers and the discussions are very well digested and abstracted by the president of the Association, who is the editor of the Proceedings, and makes a highly desirable addition to cement and concrete literature.

Small Hydro-Electric Plants

Reviewed by LEWIS F. MOODY*

KLEINE WASSERKRAFT-ELEKTRIZITAETSWERKE, BESONDERS DEREN SELBSTTAETIGE REGULIERUNGSARTEN—By C. Reindl, Ing., Landshut. Reprint from "Zeitschrift für das gesamte Turbinenwesen," Nos. 10-24, 1911. Munich: R. Oldenbourg. Paper; 9½x12½ in.; pp. 48; 70 text figures. Marks 3; American price, $1.20, net.

This pamphlet comprises a collection of a series of articles on the subject of small hydro-electric plants, giving particular attention to the automatic operation of such plants. A number of German engineers and manufacturing concerns have made a special study of such small stations, and have developed many devices for operating the machinery without the necessity of having an attendant always on the ground. The smaller stations require only occasional inspection, attention to lubrication or cleaning of racks; while the larger of these plants, although needing an operator, do not require constant supervision. Such plants are beginning to receive attention in this country; and will probably be built in greater numbers in the future. The author indicates that such automatically operated plants can be built to produce current at a cost which compares favorably, in many cases, with the prices obtaining with large stations.

The designs for small installations described in these articles are worked up with as much care as would be given to a large development, and some of the designs shown are most excellent. The entire plant is covered, beginning with timber and concrete flumes and forebays, including the design of racks or screens and intakes; then considering the design of small pipe lines; and finally the mechanical and electrical equipment of the station itself. Much space is devoted to methods of regulating the turbines or water wheels, many special devices being described, such as absorption brakes, special forms of governors, attachments for compensating for variations in head, and means for absorbing excess loads electrically. The electrical installation is well covered, many methods of automatic control being described.

Descriptions and drawings are given of a number of actual plants. The author states that the cost of the pipe line is often one of the largest items of the total investment. He shows two forms of lap-welded or seamless steel tubing using bell and spigot joints, the bell being formed by the expanded end of the tube; and gives comparative costs for steel and cast-iron pipe for small diameters. Some other features worth noting are: the use of hydraulic ejectors to improve the vacuum in the turbine draft tube; a design of small impulse turbine of high capacity and speed; and one plant of which the design is shown where the pipe line enters a tower in which the turbine is placed as in an open flume, the tower forming at the same time a standpipe or surge chamber, and being equipped with a spillway at the top.

The pamphlet will be useful to those installing small hydro-electric plants, and will be found to contain much matter of interest and value.

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RATING LOCOMOTIVES—By H. L. Cole (District Locomotive Superintendent, Indian State Railways; Assistant Secretary, Railway Board). London: W. Thacker & Co., 2 Creed Lane, E. C. Calcutta and Simla: Thacker, Spink & Co. Stiff morocco; 5x7½ in.; pp. 80; 23 charts; (13 in pocket of cover. 10/6, net; American price, $4.20, net.

The author states that his aim is to present concisely and in compact form the general principles governing engine loads and train speeds. The book relates mainly to practice in India, where the rolling stock is of a very different character from that of American railways, and it gives the adjusted tonnage system used on the Northwestern State Railways (India) for regulating freight-train loads according to drawbar pull. On these lines the ruling grades range as high as 4%. An appendix gives the method of rating compound locomotives. There are also a number of loose-sheet diagrams of engine, car and train resistance, use of velocity-head on ascending grades, stopping distances of trains, tonnage rating, etc.

An effective tonnage-rating system must include provision for securing cars loaded as nearly as practicable to their full capacity, and the rating must be based on the actual loads. This system is used very generally in this country, and is coming into use abroad. In England it has not obtained much footing. The reason for this (according to the author) is that expeditious handling is considered of greater importance than full car loads or train loads, so that delays to insure full loads might detract from efficient operation.

The various elements of train resistance are discussed, and for estimating engine resistance the author favors the method adopted by Lawford H. Fry, in which separate equations are made for different classes of engines (classified according to wheel arrangements). The elements of speed, braking, stopping distances, grade and curve conditions, atmospheric conditions, etc., are all taken into account. As far as practical application of the "adjusted" system of rating is concerned (in which the actual weight per car is a factor), it is pointed out that a table can be prepared for the use of the staff, showing for an empty or partially loaded car its equivalent weight in terms of fully loaded cars. The book is an interesting compendium of information on the subject, but it is of more interest and value as regards Indian than American railway practice.

DRILL WORK METHODS AND COSTS—A Practical Treatise Covering the Methods Used in Drilling Wells with Cable and Hollow Rod Tools. By R. R. Sanderson, Sales Manager of the Cyclone Drill Co. Published by the company, Orrville, Ohio. Cloth; 7x9¾ in.; pp. 350; illustrated.

While this book is a trade publication, it is of a technical character, giving information as to the appliances and methods used in drilling well holes, and also as to the emergency work required in recovering lost tools (at the bottom of the hole), etc. It is intended more especially for the instruction of well-drill operators. The title is misleading, as it might be understood to include ordinary rock-drill work, whereas it deals exclusively with the sinking of wells and bore holes by means of well-drilling rigs.

A new monthly journal, *Fireproof Digest*, the first issue of which appeared under date of January, 1912, is devoted to furthering the cause of fire protection. The three issues which have appeared would indicate a popular treatment of the subject, an attempt to educate owners and tenants rather than to assist builders. We gather also from these three issues that there is a foul conspiracy on foot to prevent the construction of fireproof buildings. The publication offices are at 299 Broadway, New York City.

The quarterly *Journal of the American Public Health Association* has been changed into a monthly and renamed *American Journal of Public Health*, but it still remains the official organ of the association. The *Journal* is published at 289 Fourth Ave., New York City. Dr. Livingston Farrand is now editor and Prof. Selskar M. Gunn, of the Massachusetts Institute of Technology, is

The National Italian College of Railway Engineering (Collegio Nazionale degli Ingegneri Ferroviari Italiani) has recently undertaken the publication of a monthly journal entitled "Rivista Tecnica delle Ferrovie Italiane," the first number of which is dated Jan. 15, 1912. As indicated by the title it will be devoted mostly to technical articles descriptive of the Italian government railways, but it will also discuss in a general way the broader aspects of railway engineering. The publication office is 70 Via delle Muratte, Rome, Italy.

PUBLICATIONS RECEIVED

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. The amount of postage necessary can be estimated approximately from the stated size of the book or pamphlet and the number of pages it contains. Reprints of papers read before engineering societies and printed by the authors for private circulation can often be obtained without cost by addressing the author, whose name and address is always given when known. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of a reprint of a society paper to the author of the paper. The stated American prices of foreign books are based on 40 cents per shilling and per mark for British and German books, respectively, and 30 cents per franc for French books, the extra allowances being for importation costs.]

A B C OF HYDRODYNAMICS—By Lieut.-Col. R. DeVillamil, R. Eng. (Ret.) London: E. & F. N. Spon, Ltd., 57 Haymarket. New York: Spon & Chamberlain. Cloth; 5½x8¾ in.; pp. 135; 48 text illustrations. $2.50, net.

ALTERNATING CURRENT DESIGN—By Julius Frith, M. Sc., M. I .E. E.; Consulting Engineer; Special Lecturer in Electrical Design in the Manchester University. New York: D. Van Nostrand Co. Cloth; 5½x8½ in.; pp. 118; 27 text illustrations. $2, net.

AMERICAN WOOD PRESERVERS' ASSOCIATION — Proceedings of the 8th Annual Meeting Held at Hotel Sherman, Chicago, Ill., Jan. 16-18, 1912. Baltimore, Md.: The Association: F. J. Angier, Secy.-Treas. Paper; 5¾x8½ in.; pp. 302; illustrated.

APPLIED METHODS OF SCIENTIFIC MANAGEMENT — By Frederic A. Parkhurst, M. E., Organizing Engineer; Assoc. A. S. M. E. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¾ in.; pp. 325; 9 folding plates and 48 text figures. $2, net (8/6, net).

BUILDING STONES AND CLAYS—Their Origin, Characters and Examination. By Edwin C. Eckel, C. E., Assoc. M. Am. Soc. C. E., M. Soc. Chem. Indus., F. Geol. Soc. Am. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9¼ in.; p. xv + 264; 37 text figures; 115 tables. $3, net (12/6, net).

BULLETINS, MILWAUKEE BUREAU OF ECONOMY AND EFFICIENCY—Milwaukee, Wis.: Published by the Bureau (John E. Treleven, Secy.). Paper; 6x9 in.; illustrated.

No. 14: Water Works Efficiency. 2—Present Capacity and Future Requirements. By F. E. Turneaure. Prepared under the direction of B. M. Rastall (Director). Feb. 15, 1912. Pp. 23.

No. 15: Health Department. 2—Education and Publications. By Selskar M. Gunn (and) Fred W. Luening. Prepared under the direction of John R. Commons (Director). Feb. 29, 1912. Pp. 28.

CITY OF LYNCHBURG, VIRGINIA—Standard Specifications for the Construction of Improved Pavements and Appurtenances. H. L. Shaner, City Engineer, Assoc. M. Am. Soc. C. E.; M. Assoc. Standardizing Paving Specifications, M. Am. Soc. Municipal Improvements. Lynchburg, Va.: Pub. Doc. Cloth; 6x9½ in.; pp. 136.

COAL NEAR THE BLACK HILLS, WYOMING-SOUTH DAKOTA—By R. W. Stone. Bulletin 499, U. S. Geological Survey; George Otis Smith, Director. Washington, D. C.: Pub. Doc. Paper; 6x9 in.; pp. 66; illustrated.

COMMISSION ON RELIEF OF STREET CONGESTION [Worcester] — Final Report and Recommendations, Made to the Mayor and City Council. Worcester, Mass.: Pub. Doc. [Clellan Waldo Fisher, Secy.] Stiff paper; 6¾x10½ in.; pp. 73; illustrated.

A DIGEST OF THE LAWS AND REGULATIONS OF THE VARIOUS STATES RELATING TO THE REPORTING OF CASES OF SICKNESS—By John W. Trask, Assistant Surgeon General, Public Health and Marine-Hospital Service of the United States. Public Health Bulletin No. 45, July, 1911; Treasury Department, Prepared by direction of the Surgeon General. Washington, D. C.: Pub. Doc. Paper; 6x9 in.; pp. 191.

DIRECTORY OF PORTLAND CEMENT MANUFACTURERS—Together with Manufacturers of Gypsum and Lime. Compiled and published by "The Cement Era," 1207 Morton Bldg., Chicago, Ill. Flexible leather; 3x5 in.; pp. 252; folding map. $1, net.

DREDGES AND DREDGING—By Charles Prelini, Author of "Earth and Rock Excavation," "A Treatise on Tunneling," etc.; Professor of Civil Engineering in Manhattan College, New York. New York: D. Van Nostrand Co. Cloth; 6¼x9½ in.; pp. 279; 82 text illustrations. $3, net.

DRY FARMING IN RELATION TO RAINFALL AND EVAPORATION—By Lyman J. Briggs and J. O. Belz, Physicist in Charge and Assistant (respectively) in Physical Investigations, U. S. Dept. of Agriculture. Bulletin No. 188, Bureau of Plant Industry; B. T. Galloway, Chief of Bureau. Washington, D. C.: Pub. Doc. Paper; 6x9 in.; pp. 71; illustrated.

ELEMENTARY MECHANICAL REFRIGERATION—A Simple and Non-Technical Treatise. By Fred E. Matthews, B. S., M. E., E. E.; M. Am. Soc. M. E., M. Am. Soc. Refrig. Engrs. New York and London: McGraw-Hill Book Co. Cloth; 6¼x9½ in.; pp. 172; 43 text figures; 24 tables. $2, net.

FERGUSSON'S PERCENTAGE UNIT OF ANGULAR MEASUREMENT, WITH LOGARITHMS; ALSO A DESCRIPTION OF HIS PERCENTAGE THEODOLITE AND PERCENTAGE COMPASS—For the Use of Surveyors, Navigating Officers, Civil and Military Engineers, Universities and Colleges. By John Coleman Fergusson, M. Inst. C. E. London, New York, Bombay and Calcutta: Longmans, Green & Co. Cloth; 6½x10½ in.; pp. 467; five plates and 12 text figures. $20, net.

FORNEY'S CATECHISM OF THE LOCOMOTIVE—Part I. By Geo. L. Fowler, Consulting Mechanical Engineer; Associate Editor "Railway Age Gazette." Third edition, revised and enlarged. New York: Simmons-Boardman Publishing Co. [Selling Agents, McGraw-Hill Book Co., New York City.] Cloth; 6x8¾ in.; pp. 644; 6 plates and 475 text figures. $3, net.

GERMAN VARNISH MAKING—By Prof. Max Bottler, of Würzburg. Authorized translation with "Notes on American Varnish and Paint Manufacture," by Alvah Horton Sabin, M. S., M. Am. Chem. Soc.; A. S. Testing Materials, etc.; Consulting Chemist, National Lead Co. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5½x8¼ in.; pp. vii + 363; 55 text figures. $3.50, net (15/- net).

HAMMOND'S COMPLETE MAP OF NEW YORK—Showing Electric and Steam Railroads, Steamboat Lines, Counties, Congressional Districts, and all Cities, Towns and Villages, New Census Figures; also a new Hotel Directory, with Rates, etc. New York: C. S. Hammond & Co., 30 Church St. Folder; 3½x7½ in.; 15c., net.

HISTORICAL PAPERS ON MODERN EXPLOSIVES—By Geo. W. MacDonald, M. Sc. (Melb.); Head of Research, Messrs. Curtis's & Harvey, Ltd. With an Introduction by Sir Andrew Noble, Bart., K.C.B., F.R.S. London and New York: Whittaker & Co. Cloth; 6¼x10¼ in.; pp. 192. $2.50, net.

INTERSTATE COMMERCE COMMISSION—Annual Report, Dec. 20, 1911. Washington, D. C.: Pub. Doc. Cloth; 6x9 in.; pp. 355.

INTRODUCTION TO ANALYTICAL MECHANICS—By Alexander Ziwet and Peter Field, Ph. D., Professor and Assistant Professor (respectively) of Mathematics in the University of Michigan. New York: The Macmillan Co. London: Macmillan & Co., Ltd. Cloth; 5x7¾ in.; pp. 378; 96 text figures. $1.60, net.

LABORATORY MANUAL FOR THE USE OF STUDENTS IN TESTING MATERIALS OF CONSTRUCTION—By L. A. Waterbury, C. E., Professor of Civil Engineering, University of Arizona; M. Am. Soc. Testing Materials; Assoc. M. Am. Soc. C. E. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 5x7½ in.; pp. 270; 68 text figures. $1.50, net. (6/6, net.)

MANUFACTURERS: UNITED STATES—Abstract of Statistics of Manufacturers for States, Cities and Industries. Bulletin, 13th Census, 1910. Prepared under supervision of W. M. Steuart, Chief Statistician for Manufacture. Washington, D. C.: Pub. Doc., Dept. of Commerce and Labor, Bureau of the Census; E. Dana Durand, Director. Paper; 9x11½ in.; pp. 96.

MASCHINENTECHNISCHES LEXIKON—Lieferung 8-13. Herausgegeben von Ing. Felix Kagerer. Wien: Druckerei- und Verlags- Aktiengesellschaft. Paper; 7x10½ in.; pp. 673; illustrated. Price per part 80 h. = 70 pf. = 95c., net.

NEW HAMPSHIRE HIGHWAYS—Report of an Inspection of Highways in the State of New Hampshire, August, 1911. By Charles H. Hoyt, C. E., Superintendent of Construction, U. S. Office of Public Roads. Bulletin No. 42—Office of Public Roads; Logan Waller Page, Director. Washington, D. C.: Pub. Doc. Paper; 6x9 in.; pp. 36; 41 plates.

PRACTICAL SEWERAGE AND SEWAGE DISPOSAL—By H. C. H. Shenton, F. S. E., M. I. Mun. E., M. R. San I. London: S. Edgecumbe Rogers (27a, Farringdon St.). Cloth; 5x7½ in.; pp. 148; illustrated. 3/6, net; American price, $1.40, net.

THE RAILWAY SIGNAL DICTIONARY—An Illustrated Vocabulary of Terms Which Designate American Railway Signals, Their Parts, Attachments and Details of Construction, etc. Second edition. Revised 1911 by A. D. Cloud, Editor of "The Signal Engineer," and H. H. Simmons, Associate Editor of the "Railway Age Gazette," under supervision of a committee. New York and Chicago: Railway Age Gazette; The Signal Engineer. London: The Railway Gazette. Cloth; 8x12 in.; pp. 561; 3899 text figures. $3.50, net (leather, $6, net).

A SHORT COURSE IN GRAPHIC STATICS—For Students in Mechanical Engineering. By William Ledyard Cathcart, M. Am. Soc. Naval Engrs.; M. Am. Soc. M. E., and J. Irvin Chaffee, A. M., Professor of Mathematics, Webb's Academy of Naval Architecture and Marine Engineering; M. Soc. Naval Archts. & Marine Engrs. New York: D. Van Nostrand Co. Cloth; 5x7¾ in.; pp. 183; 58 text figures. $1.50, net.

STARTING CURRENTS OF TRANSFORMERS—With Special Reference to Transformers with Silicon Steel Cores. By Trygve D. Yensen. Bulletin No. 55, University of Illinois, Engineering Experiment Station. Urbana, Ill.: The University. London: Chapman & Hall, Ltd., European Agent. Paper; 6x9 in.; pp. 43; illustrated. 25c., net.

THE STEAM ENGINE AND TURBINE—A Text-Book for Engineering Colleges. By Robert C. H. Heck, M. E., Professor of Mechanical Engineering, Rutgers College. New York: D. Van Nostrand Co. Cloth; 6x9½ in.; pp. xl + 631; 402 text figures; many tables. $5, net.

THE SUCTION CAUSED BY SHIPS—And the "Olympic"-"Hawke" Collision. The case analyzed and cleared up with a chart. By E. S. Bellasis, M. Inst. C. E., Author of "Hydraulics," etc. London: E. & F. N. Spon, Ltd. Paper; 5½x8½ in.; pp. 26; five illustrations.

THE TEACHING OF PHYSICS FOR PURPOSES OF GENERAL EDUCATION—By C. Riborg Mann, Associate Professor of Physics, the University of Chicago. New York: The Macmillan Co. Cloth; 5¼x8 in.; pp. 304. $1.25, net.

TESTS OF THE ABSORPTIVE AND PERMEABLE PROPERTIES OF PORTLAND CEMENT, MORTARS AND CONCRETES—Together with Tests of Damp-Proofing and Waterproofing Compounds and Materials. By Rudolph J. Wig, Associate Engineer-Physicist, and P. H. Bates, Chemist, Bureau of Standards. Technologic Paper No. 3, Bureau of Standards (Department of Commerce and Labor); S. W. Stratton, Director. Washington, D. C.: Pub. Doc. Papaer; 7x10 in.; pp. 127; 53 text figures; 25 tables.